

Rule the Night
WE TEST SUPER-TOUGH FLASHLIGHTS **P 32**

The DeltaWing
HOW A REVOLUTIONARY RACE CAR WAS BORN **P 76**

The End of Cash?
YOUR NEXT WALLET IS A SMARTPHONE **P 52**

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P 68

Popular Mechanics

Home Adventure Technology Science Automotive

09.12
PopularMechanics.com
Volume 189, No. 9
Since 1902

WEEKEND DIY

Create a
Backyard
Movie Theater
P 25

Assemble a
Fire Pit
P 96

Find Treasure
In a Junkyard
P 120

And Much
More!

Mega

Engineering

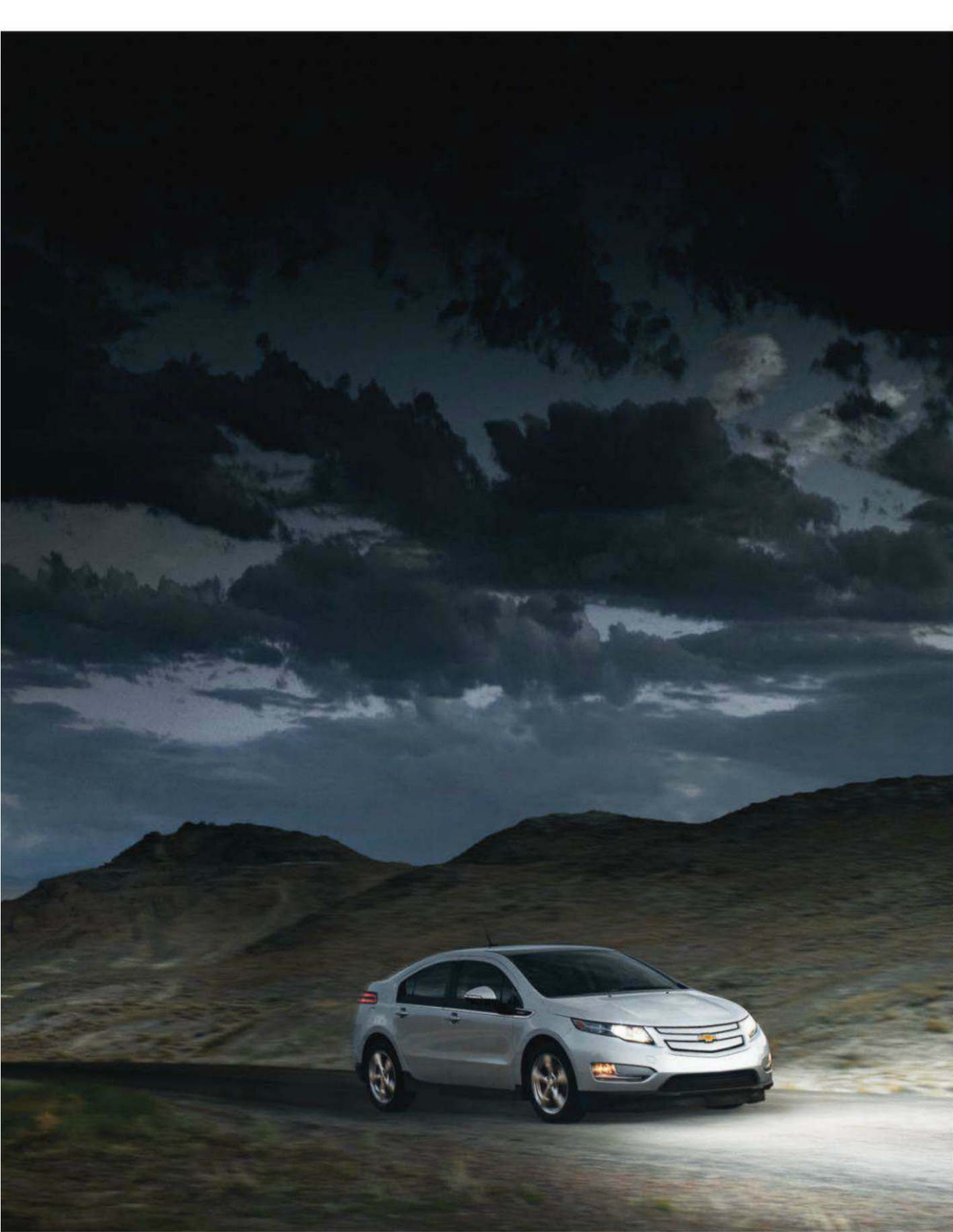
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NEXT-GEN AIRCRAFT CARRIER,
SUPER-DUTY ROCKETS,
& MORE! **P 60**

AN ELECTRIC CAR. NO ELECTRICITY FOR MILES. HERE'S WHERE IT GETS INTERESTING.

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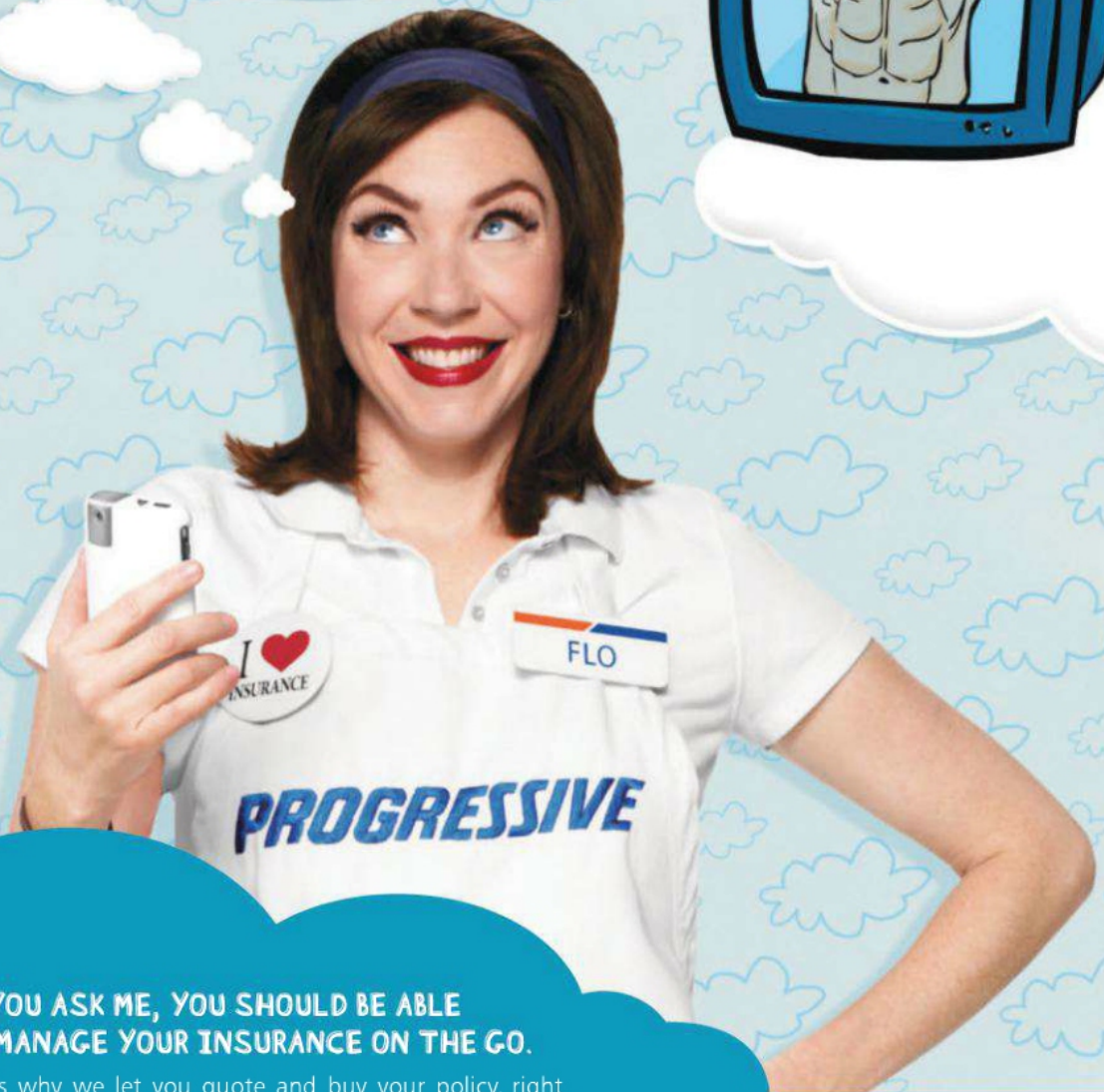
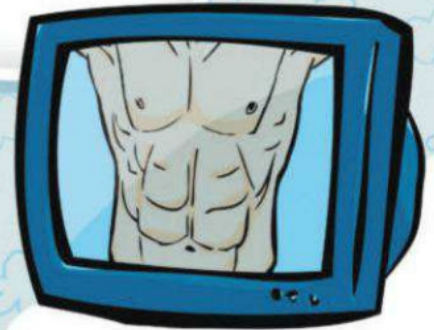
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Racing in the DeltaWing at Le Mans inspires intensity. Just check out Marino Franchitti's look in the side mirror before a qualifying session at the 24 Hours of Le Mans.

PopularMechanics

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Marvels of 21st-century engineering: a 1776-foot skyscraper, a spaceport, a 1.5-mile floating concrete bridge, and more. BY DAVIN COBURN 60

Backyard Genius 2012 Our annual tribute to the best in DIY creativity—including a Nerf gun Tesla cannon. BY DAVIN COBURN 68

The Fifty Percent Solution Can the DeltaWing's radical design prove that motorsport innovation involves more than larger engines and lighter chassis? BY STEVEN COLE SMITH 76

ON THE COVER

Perspective is everything. Our vertigo-inducing cover is the creation of illustrator Vladimir Shelest, who was inspired by the dramatic perspectives found on iconic PM covers from the '30s and '40s. The Bangkok-based Moscow expat created a digital 3D model of New York's One World Trade Center and then rendered it from a dizzying top-down view. The result is an instant classic.



PopularMechanics

W
weekend

24 Pages of DIY

96. **Home**

How to build a prefabricated masonry fire pit (easier than you think) and carve half-log benches to go with it—in one day.

Early Adopter Our launcher takes the joy of tossing water balloons to a whole new level.
Don't Be an Idiot So, this guy steps on a rake...

108. **Adventure**

Five tips to put more fish on the end of your line.

110. **Tech**

All you need to know about soldering, the stepping stone to DIY electronics.

Digital Clinic A new way to share media: Wi-Fi Direct.

118. **Science**

A video game for future virologists tests users to make a new flu vaccine.

120. **Auto**

Where some see wreckage, we see beauty and bargains. How to scour your local junkyard.
Car Clinic Repair a finicky sunroof.

IGNITION



COMPLAINTS DEPARTMENT

Your magazine has a problem: I seldom have any interest in the content! Why do you write so much about automobiles? I do not want to hear about new cars. The July issue had only one article I liked, on solar storms ["Welcome to the New Solar Maximum," page 86]. (It was well done.) Also, why do you insist on fancying up technical articles with color and sidebars? **WILLIAM PARK, PRESCOTT, AZ**

?#@*8%!



What You Said

(ABOUT OUR JULY ISSUE AND MORE)

We read all of your comments, tweets, and letters. But please, try not to spill your lunch on the envelopes.

CURATED BY
 ALYSON SHEPPARD



TALK TO US

email popularmechanics@hearst.com
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Writer Sam Smith's feature story about driving a Mustang Boss 302 cross-country with his father ("Freedom of the Road," July) particularly moved readers.

• "The article hooked me immediately," Jeff Buchanan of Tampa, Fla., wrote. "I've always been a GM man, but you can't ignore a Mustang. My dad taught me how to fix anything, just like Sam's dad, and the deeper I got into the story, the more tender memories it brought back from my youth. You made me feel like I was there too, and I'm going to hold on to those good feelings for a while to come."
 • James Medlock of Cibola, Texas, said the Boss 302 story—and the rest of our car coverage—was tops. "I devoured the July issue; you never disappoint."
 • Bill Maynard of Allen, Texas, felt the story was about more than the car. "I'm glad to see articles like this," he wrote. "It shows that your magazine

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supports those of us who want to make things work again.” ● Terry Willcox of Longwood, Fla., read the story after attending a motorsports driving school with his brother. “Reading about that car is like entering a time warp,” he wrote. “Everyone in my family has had a Mustang, and the Boss is the best. Compliments to Sam on a powerful read. Life is short, and there’s nothing better than sharing special times with friends and family.” ▲

● **Secrecy: Maintained** Superb article on the special ops (“Looking Downrange,” July). It is very hard to write a lot about how these guys train and carry out their assignments without giving away too much information, but you pulled it off. **BILL WALLER, WINTER SPRINGS, FL**

● **Home Safety Appreciation** Thank you so much for bringing the Home Safety Prep Show to New Orleans. We’ve needed something like this for a long time, and my mother and I learned a ton. Please make this an annual event. You guys rock! **MATTHEW CONSTANT, METAIRIE, LA**
Awesome, Matthew! This was actually our second annual Home Safety Prep Show tour. With survival experts in tow, we visited three cities and provided hands-on workshops in disaster-proofing your life. We look forward to serving communities for many more tours to come. ✕

IGNITION

WHAT YOU SAID



What We're Up To

(PM NEWS & EVENTS & STAFFERS
ON THE SCENE)

We're really busy in September

SEPT. 8: FIRST Tech Challenge

2012–2013 season kickoff

SEPT. 13–16: Route 66 Rendezvous, San Bernardino, Calif.

SEPT. 27: Frankfurt Motor Show, Germany

SEPT. TBA: Space shuttle

Endeavour ferry flight to California

(a) Senior editor Joe Pappalardo takes the mic on ABC Radio’s Men’s Life channel. (b) Editor-in-chief Jim Meigs [right] talks shop at our Home Safety Prep Show in New Orleans with hosts Colby Donaldson [History’s *Top Shot*], Mykel Hawke [Discovery’s *Man, Woman, Wild*], and Chris Grundy [DIY Network’s *Cool Tools*]. (c) Flashlight as hammer? Yep. Special projects assistant Steve Rousseau conducts a PM Abusive Lab Test [pg. 32]. (d) Publisher Bill Congdon gets dirty at our Rebuilding Together volunteer day in Brooklyn.



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Employee of the Month



David Dunbar is ferocious with the red pen and a hockey stick. PM's resident Canadian is also a consulting producer for History channel specials, including *101 Gadgets That Changed The World*. Watch for more familiar PM faces in new shows this fall.

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THE KID WANTS TO KNOW

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"Was Wi-Fi
invented by
accident?
What was
it originally
used for?"
Kort R., 15,
Folsom, CA

Wi-Fi was created on purpose and first used in 1991 to transmit data between bar code scanners and cash registers, according to Greg Ennis, technical director at the Wi-Fi Alliance. Soon after that, the Institute of Electrical and Electronics Engineers set standards for wireless data transmission over a computer network, and in 1999 "Wi-Fi" was branded. Its growth since then is astonishing. "Wi-Fi quickly became what we know it as today: the default access people have to the Internet," Ennis says. — Steve Rousseau

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ON THE WEB

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DRONES COME HOME

The Pentagon has become increasingly reliant upon unmanned aerial vehicles for surveillance and airstrikes. Now drone sensors developed for the battlefield are coming to American airspace. popularmechanics.com/drones

NOT YOUR DAD'S RV



These extreme campers aren't made for a quiet weekend at the lake. They were built for overlanding: long-distance four-wheeling to remote parts of the country (or the world). popularmechanics.com/extremeRV

BALCONY BBQ

Yes, some backyard grillmasters think that it's anathema to cook burgers or dogs on an electric grill. But our comparison test shows that those who don't have the space or budget for a big charcoal cooker can still grill some tender meat and tasty veggies. popularmechanics.com/electricgrill

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IGNITION

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THE WEIGHT OF A RAINDROP IMPACT PINS A MOSQUITO IN FLIGHT.

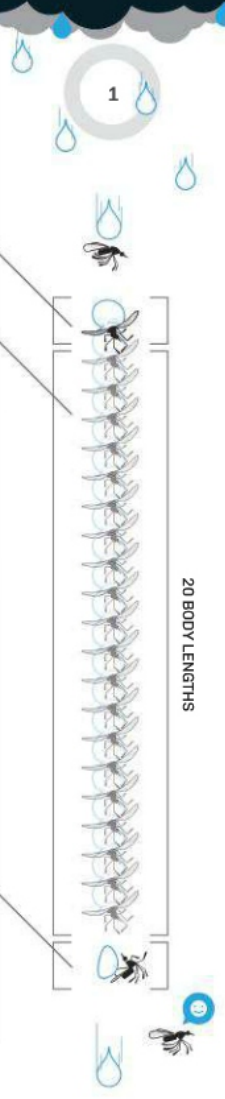
THE INSECT FALLS ABOUT 20 BODY LENGTHS.

ONCE ITS WINGS AND LEGS HAVE CREATED ENOUGH WIND RESISTANCE, THE MOSQUITO CAN ESCAPE, UNSCATHED.

ESCAPE ARTISTS

Riders on the Storm

Raindrops hit mosquitoes with the relative force of a bus. Yet, scientists have discovered, the insects can shrug off the impact and thrive in the rain. After analyzing high-speed video of raindrops hitting mosquitoes, researchers at Georgia Tech found that drops strike the insects once every 25 seconds in a storm. When the falling water scores a direct hit between the wings, the bug is momentarily pinned. But in a split second its long legs and wings act as a parachute, generating enough wind resistance to allow for an escape. Georgia Tech engineer David Hu, co-author of the mosquito study, says larger insects don't need the same escape strategy. "A raindrop hitting a dragonfly will just bounce off," he says. "But that force is 100 times greater on a tiny mosquito and would be deadly if it didn't have this way out." — STEVE ROUSSEAU



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THE DRIVE TO THE GAME
THE "WE'RE LATE, JUST CHANGE ON THE WAY" SPRINT
THE SUMMER-FRIDAY DAYTRIP
THE CUT-OUR-OWN-CHRISTMAS-TREE OUTING
THE BACHELOR-PARTY WEEKEND
THE SNOW DAY
THE CAMPING TRIP
THE DRIVE OVER INDEPENDENCE PASS
THE "WE DON'T NEED AIRLINES" SUMMER VACATION
THE 18-HOURS STRAIGHT-THROUGH ROAD TRIP
THE TWO-LANE HIGHWAY PASS
THE SCENIC OVERLOOK
THE "HEY, LOOK, THERE'S A MOOSE" DRIVE-BY
THE WHITE-WATER RAFTING ADVENTURE
THE COLLEGE-FOOTBALL TAILGATE
THE RIDE HOME FROM THE DUDE RANCH
THE RUN TO THE DOG PARK
THE ROAD TRIP

THE SUV / MADE BETTER

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*18 city/25 highway/21 combined mpg for 2WD models. Based on 2012 EPA mileage estimates. Use for comparison purposes only. Do not compare to models before 2008. Your actual mileage will vary depending on how you drive and maintain your vehicle. ©2011 American Honda Motor Co., Inc.

NEWS
BRIEF /The
Hottest
Thing
Ever

Long Island is scorching. Nuclear physicists using Brookhaven National Lab's Relativistic Heavy Ion Collider smash gold ions together at nearly the speed of light and have earned the record for hottest man-made temperature ever: 4 trillion degrees Celsius—that's 250,000 times hotter than the center of the sun. Experiments revealed the neutrons and protons inside the gold nuclei "melt" on impact, releasing the fundamental particles quarks and gluons. The particles then form into a liquid-like plasma that is only known to have existed in nature one-millionth of 1 second after the big bang. To learn more about the nearly friction-free plasma, Brookhaven scientists propose hitting their ions with a stream of ultra-high-energy electrons. Meanwhile, inside the Large Hadron Collider in Europe's CERN lab, lead ions are smashing together into their own primordial plasma and are expected to break Brookhaven's official record by 30 percent.

—A.H.

ADVENTURE



Daredevil Gary Connery cupped his wings at 200 feet above the runway to reduce his speed for landing.

Altitude
2400 feet

Top speed
Horizontal: 85 mph
Vertical: 60 mph

Landing speed
Horizontal: 50 mph
Vertical: 15 mph

Runway
350 feet long
12 feet high

Wing-Suited Flyer Lands Safely



British stuntman Gary Connery became the first to leap out of an aircraft wearing a wing suit and safely land—without using a parachute. Connery donned a custom wing suit made by Florida-based TonySuits that allowed him to reach a top speed of 85 mph. The 40-second flight ended when he crashed into a runway made of 18,500 cardboard boxes, much to the relief of his wife, Vivienne, on the ground. "He is obviously totally bonkers," she said. "I'm just relieved it's all over." TonySuits won't sell its specialty suit to anyone who hasn't already completed 200 wing-suit jumps (in case you were getting any ideas). —ALEX HUTCHINSON

*Based upon Goodyear internal wet handling test on 225/45R17 tire versus Michelin Pilot Sport A/S plus. ©2012 The Goodyear Tire & Rubber Company. All rights reserved.

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J

apan's Hayabusa spacecraft returned to Earth in 2010 with more than 1500 pristine dust particles from the asteroid Itokawa. The latest electron microscope analysis shows that the tiny particles—some barely a tenth of a millimeter across—are covered with even tinier craters and microdust particles sometimes melted onto the surface. The findings shed new light on what sorts of particles are bombarding asteroids and how fast they're traveling. Because asteroids are an intermediate step in a rocky planet's long cosmic evolution from scattered dust, the samples will help scientists understand how planets form. — ALEX HUTCHINSON

AVIATION

Watery Eyes

THE NAVY IS RECEIVING ITS NEWEST UAV, THE MQ-4C BROAD AREA MARITIME SURVEILLANCE (BAMS) TRITON. THE AIRFRAME MAY LOOK FAMILIAR—IT'S BASED ON THE GLOBAL HAWK—BUT THIS DRONE HAS SENSORS THAT COULD REVOLUTIONIZE NAVAL WARFARE. BY JOE PAPPALARDO



SPINNING ACTIVE ELECTRONICALLY SCANNED ARRAY (AESA) RADAR

AESA radars can cover hundreds of miles, but this one spins, so there are no blind spots. The radar has modes that can search the surface or track ships.

INFRARED/ELECTRO-OPTICAL SENSORS

Day/night cameras are used for target tracking and taking high-resolution video.

AIR-TO-AIR RADAR

Due Regard radar is a step toward "sense and avoid" technology that is needed to operate UAVs in national airspace (see below).

AUTOMATIC IDENTIFICATION SYSTEM (AIS) RECEIVER

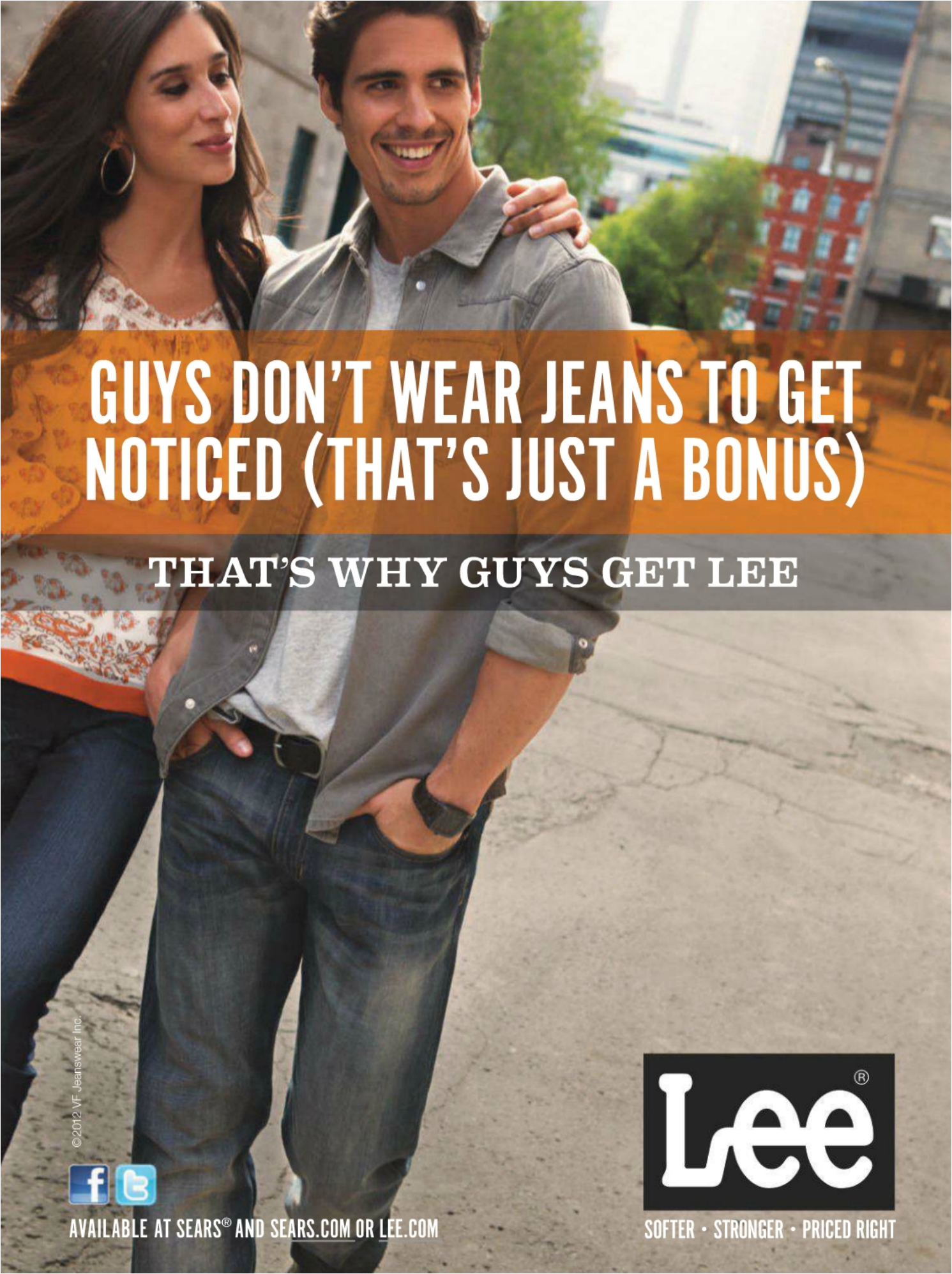
AIS data, using onboard sensors, detail the identity, speed, and previous track of any vessel in real time for users on the ground.

TECH WATCH

DRONES GOING DOMESTIC

CIVILIAN, MILITARY, AND LAW-ENFORCEMENT UAVS WILL SOON BE ALLOWED ACCESS TO U.S. AIRSPACE. HERE'S WHERE THE REGULATIONS STAND:





**GUYS DON'T WEAR JEANS TO GET
NOTICED (THAT'S JUST A BONUS)**

THAT'S WHY GUYS GET LEE

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ANIMAL HEROES OF SCIENCE

Patient Pooch

Callie is a 2-year-old Southern squirrel hunter who knows how to sit still. Researchers at Emory University trained her to crawl into the cylindrical bore of an fMRI brain scanner, hold her head motionless, and recognize hand signals. She's part of a new effort to understand how dogs think. Early results show, for example, that when her owner signals that she's about to receive a doggy treat, neural activity increases in the caudate region of her brain—the same region associated with rewards in humans. The researchers hope to settle long-standing debates over how much language dogs understand and whether they feel empathy. — ALEX HUTCHINSON

Callie wears earmuffs to protect her hearing during the fMRI.

TECH WATCH

GLOSSARY

YARKOVSKY EFFECT

When an asteroid absorbs sunlight and emits that energy as heat, the space rock changes trajectory slightly. This Yarkovsky effect produces a force of only a half-ounce per incident, but it accumulates over time. The team behind NASA's OSIRIS-REx craft, which is due to rendezvous with asteroid 1999 RQ36 in 2019, has been calculating the rock's orbit to ensure a safe landing. In the past 12 years, the effect has pushed the 68-million-ton asteroid 100 miles off-course. —A.H.

60-SECOND GENIUS



Richard Martin,
author and
clean-energy expert

Q

What's thorium, and how can it create clean energy?

A: Thorium is a radioactive element that is a far safer and cleaner source of nuclear power than uranium. In a liquid fluoride thorium reactor, or LFTR, reactions occur in a fluid, so a meltdown is physically impossible. Thorium also has a high burn-up rate, meaning you can use a greater percentage of the energy that's inherent in the fuel—as much as 50 percent compared with the 3 to 5 percent you get with uranium. And LFTRs can be used to process the waste from existing conventional reactors so that it can be recycled to start new thorium reactors. Thorium is four times as abundant as uranium, and it's no good for building bombs.

— AS TOLD TO
ALISON BROWER

1&1 MY WEBSITE

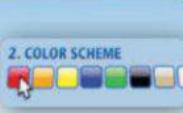
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NEWS BRIEF /

End of Needles

Don't like needles? Take heart: Scientists have developed a way to inject drugs directly through skin by blasting them in a narrow, powerful jet of fluid. Engineers at MIT have created an injector that uses a strong magnetic field to propel fluid through an opening the size of a mosquito's proboscis. The key advance is that doctors can adjust the electric current that creates the field to produce exactly the force needed to inject drugs to different depths in different parts of the body. The researchers are currently investigating a way to use the method with powdered drugs, which are more useful during vaccination drives in developing nations because powders don't need to be refrigerated.

— ALEX HUTCHINSON

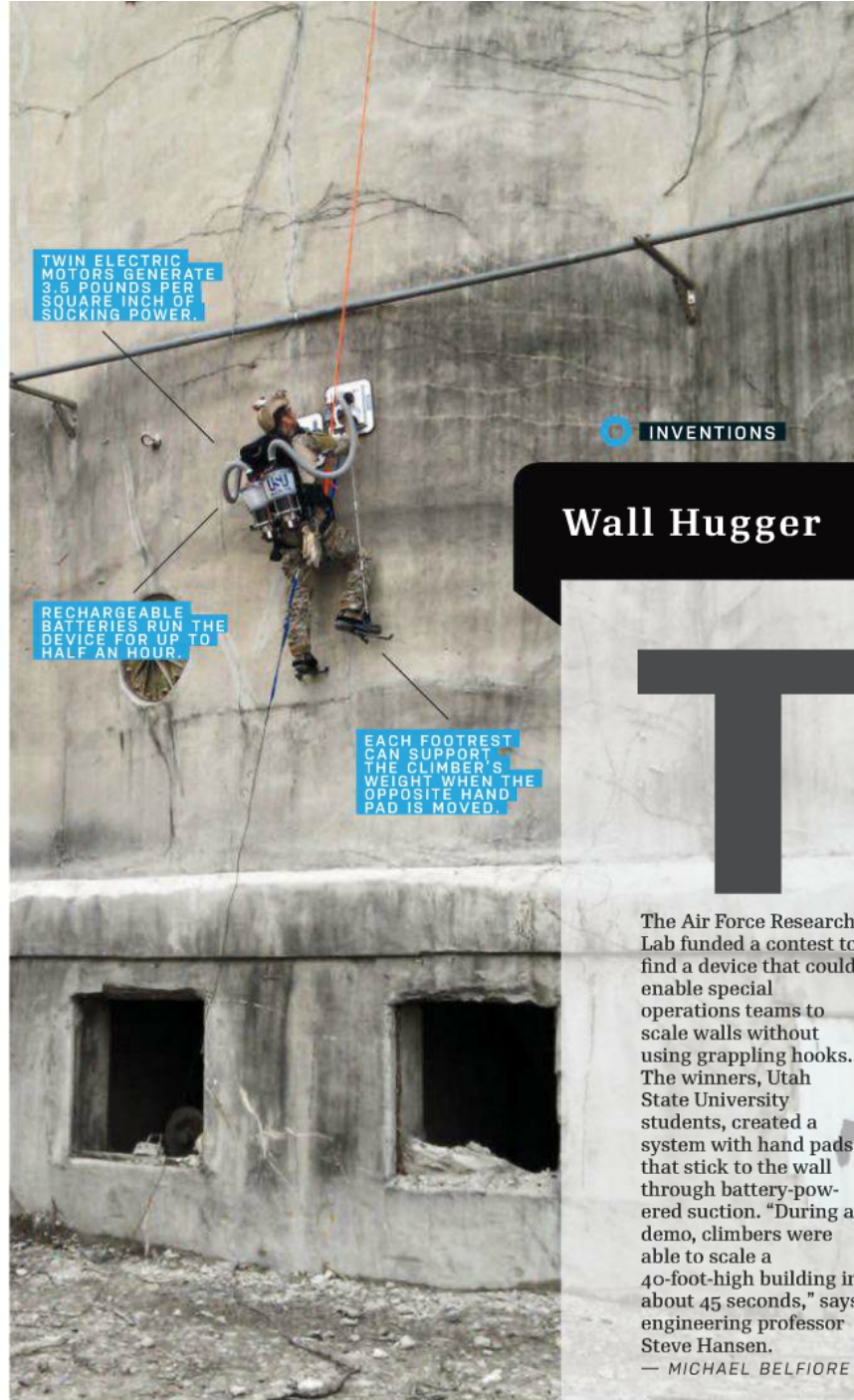
TECH WATCH



NEWS BRIEF /

Smart Asphalt

Cracked, rutted roads pocked with potholes are dangerous to drive on and expensive to repair. Civil engineers at Michigan Technological University have a solution: Add a small dose—between 2 and 4 percent by weight—of nanoclay to the asphalt binder. Initial tests show that the clay helps increase asphalt viscosity by more than 40 percent, making it less likely to deform in hot weather or heavy traffic conditions. The researchers are also testing other potential asphalt additives such as nanosilica and are experimenting with higher percentages of nanoclay to see if that helps to prevent rutting and cracking. — A.H.



TWIN ELECTRIC MOTORS GENERATE 3.5 POUNDS PER SQUARE INCH OF SUCKING POWER.

RECHARGEABLE BATTERIES RUN THE DEVICE FOR UP TO HALF AN HOUR.

EACH FOOTREST CAN SUPPORT THE CLIMBER'S WEIGHT WHEN THE OPPOSITE HAND PAD IS MOVED.

INVENTIONS

Wall Hugger

T

The Air Force Research Lab funded a contest to find a device that could enable special operations teams to scale walls without using grappling hooks. The winners, Utah State University students, created a system with hand pads that stick to the wall through battery-powered suction. "During a demo, climbers were able to scale a 40-foot-high building in about 45 seconds," says engineering professor Steve Hansen.

— MICHAEL BELFIORE

THE CHALLENGE

Get climbers over a 90-foot sheer concrete face without using grapples or ropes.

THE WINNER

The Personnel Vacuum Assisted Climber, which uses suction to adhere 300 pounds to a wall.

NEXT STEP

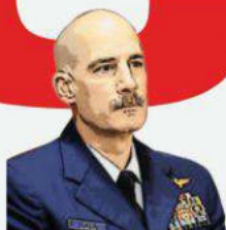
Make the system quieter and lighter than the 45-pound prototype.

C

CHANGING PLANET

America's Arctic Challenge

Contracting sea ice is making the far north more accessible. Nations are now scrambling to utilize the region's resources—building ice breakers for safe passage, mapping the seafloor to try to extend their sovereignty, and exploring for oil and gas. The U.S. Coast Guard is expanding its presence with a mission called Arctic Shield. Here's what has been happening off the northern coast of Alaska this summer. — JERRY BEILINSON



"There's a whole new ocean opening up in the Arctic."

— U.S. COAST GUARD REAR ADM. THOMAS P. OSTEBO



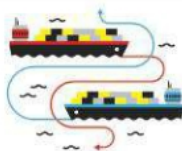
NAUTICAL TOURISM

"Cruise ships are the fastest growing activity in the Arctic, not oil drilling," says James Watson, director of the Interior Department's Bureau of Safety and Environmental Enforcement. The trip comes with risk: A stricken cruise ship could take days to rescue—and only 10 percent of the Arctic's seafloor has been mapped.



WHALE HUNTING

Inupiat crews hunt whales in open boats launched from the villages of northern Alaska. Western Arctic bowhead whales migrate through the region in the spring and fall. Shell Oil agreed to stop drilling when necessary to avoid interrupting the hunts.



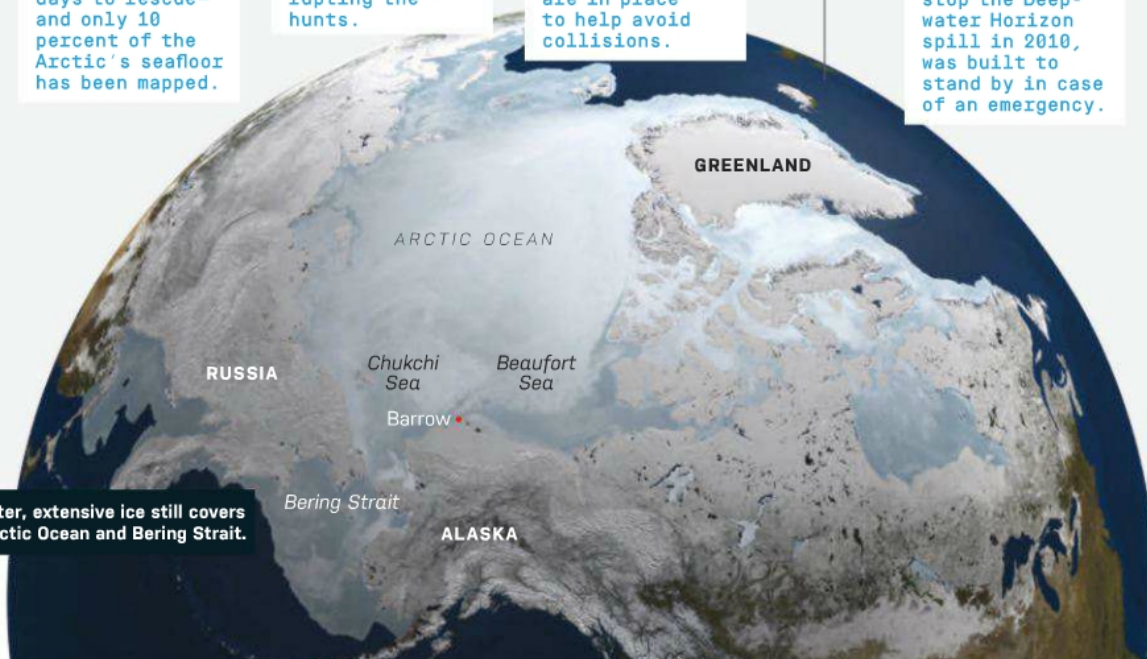
INDUSTRIAL PASSAGE

Shipping in U.S. Arctic waters is surging, with 1000 transits each summer through the Bering Strait, up from as few as 150 five years ago. The passage has a narrow choke point, but no traffic separation schemes or onshore radar are in place to help avoid collisions.



OIL AND GAS EXPLORATION

According to U.S. government estimates, the Arctic may contain 90 billion barrels of recoverable oil. This year Royal Dutch Shell prepared two drilling rigs and dozens of support vessels to drill the first exploratory oil wells on Alaska's Outer Continental Shelf in two decades. A capping stack, like the one used to stop the Deepwater Horizon spill in 2010, was built to stand by in case of an emergency.



In winter, extensive ice still covers the Arctic Ocean and Bering Strait.

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Wrist Housing



Head Strap Mount



Suction Cup
Mount



Handlebar Seatpost
Mount



Vented Helmet
Strap



The screen of a DIY movie theater can be as low-fi as a crisp white sheet or as high-tech as this Camp Chef screen [page 26].

2

Now Showing

Making the most of these dog days—and nights—isn't just about pool parties and patio barbecues. Big-budget blockbusters are an essential summer staple for vitamin D-deprived cinephiles and beach bodies alike. But you can only make so many trips to the multiplex for mediocre movies. Take control of your plein-air pixels by creating an outdoor theater that celebrates—and even outshines—a drive-in theater. Whether your guests are watching battling aliens, sharks, or cybernetic organisms hopping back in time, you'll be the most popular person in the neighborhood with your DIY backyard cinema. — SCOTT PIERCE

Upgrade

GEAR

TOOLS

GADGETS

When purchasing a projector, consider contrast ratio—the measurement of the brightest color [white] to the darkest [black] that a display system can produce. A high ratio yields crisper images and more vibrant colors and can better create subtle, shadowy tones—a feature that's important for movies such as *The Godfather*, where key scenes take place in dimly lit rooms.



CAMP CHEF BACKYARD BIG SCREEN, \$283

Film buffs will approve of the 16:9 aspect ratio and the opaque black layer behind the white face of the 120-inch-diagonal screen, which blocks out distracting background light. A 9.5-foot-tall frame stabilizes the 44-pound apparatus on breezy nights.



CYBER ACOUSTICS POWERED SPEAKER SYSTEM, \$40

The rest of your theater is expensive, so go for cost-effective portable speakers. Sound from this three-piece set—it hooks up to the projector or the DVD player, depending on the system—carried over a backyard and wowed our test audience.



VALLARTA OUTDOOR DRINK DISPENSER, \$59

This dispenser stylishly holds 8 quarts of your drink of choice. The stainless-steel spigot keeps the juice flowing. Oh, and we'd like to thank whoever spiked the lemonade.

STRATHWOOD BASICS ANTI-GRAVITY ADJUSTABLE RECLINER, \$65

Sit comfortably through even epic films (*Lawrence of Arabia*, anyone?), thanks to a steel suspension that evenly distributes weight. The Textilene seat offers a variety of positions for both legs and back, so you can put your feet up after intermission.

JAWS BLU-RAY, \$30: To celebrate its centennial, Universal is restoring some of its classic films—starting with *Jaws*. A team ran the original negative through a wet scanner to fill in shallow scratches, then digitally repaired tears and deep gashes and corrected color frame by frame. After watching it, you won't even want to go into your pool.

UPGRADE



BUDGET: 3M MP220, \$500

This lightweight, battery-powered projector has 2 GB of internal memory and a microSD card slot—perfect for slideshows on screens up to 75 inches. The Android OS interface enables video projection from an iPad at 65 lumens. The MP220 compensates for the so-so moving-image quality with long-lasting power and portability.



MODERATE: Optoma HD20, \$830

With a 4000:1 contrast ratio, 1700 lumens, and 1080p resolution, the HD20 produces clear, bright images and pleases a big crowd, filling screens as large as 300 inches. Although you have to manually adjust the projection height, this projector shines at less than \$1000.



HIGH-END: EPSON POWERLITE HOME CINEMA 5010, \$2600

Deep-pocketed, 3D-loving movie buffs might want to spring for this machine. A high-performance, air-spaced Fujinon lens; 2400-lumen color; and a cinema filter keep images sharp and colors true, while the 200,000:1 contrast ratio brings out subtleties that might otherwise be lost. The 5010 enters 3D mode with the flip of a switch (sorry, glasses not included).





SHE GETS IT.

Don't look back...just keep on running!
For movie thrills that explode off the screen, LG Cinema 3D TV is the ultimate in nail-biting excitement. Only LG delivers this action-packed lineup: the total-immersion brilliance of Full HD 3D picture quality, battery-free glasses, the versatility of 2D to 3D conversion, a Magic Remote and a virtually frameless Cinema Screen design. Don't stop now... because you don't get it 'til you got it!

ONLY LG's GOT IT.



"LG HAS A BIG WINNER
ON ITS HANDS." -Digital Trends

LG CINEMA 3D
Smart TV

For more information, visit www.lg.com

Design, features and specifications are subject to change without notice. Digital Trends quote references 55" Class (54.6" diagonal) LM6700 Cinema 3D LED TV with Smart TV. For a small percentage of the population, the viewing of stereoscopic 3D video technology may cause discomfort such as headaches, dizziness or nausea. 6 glasses included. Additional glasses sold separately. Visit www.lg.com for details. © 2012 LG Electronics, Inc., Englewood Cliffs, NJ. LG Design & LG Life's Good are trademarks of LG Electronics, Inc. Screen image is simulated.

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Directions

STAIN

- Apply with a natural bristle brush, foam brush, staining pad or rag
- While stain is still wet, remove excess with a clean cloth in the direction of the grain
- Allow stain to dry a minimum of 8 hours before applying a clear protective finish

FINISH

- Apply polyurethane with a natural bristle brush, in one direction with the grain
- Let dry at least 4-6 hours, then sand with very fine sandpaper (220 grit) to ensure an even finish and proper adhesion of any additional coats
- Apply second coat. If a third coat is desired, repeat the above step before application
- After final coat, allow 24 hours before normal use

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CUBE 3D PRINTER, \$1300

W

When the history of 3D printers (which use plastic to print layer by layer a physical version of a digital file) is written, this Wi-Fi-enabled model will appear in the chapter about transitional devices. The price keeps it from the mainstream, but its features—including robust software and support packages, available on the company website, cubify.com—make it a reasonable investment for serious makers and product-prototypers.

UPGRADE



NZXT CRYO E40, \$28

Summer's nearly gone, but there's never a bad time to keep your computer from getting hot and bothered. Though it has all the visual appeal of an HVAC vent, the NZXT laptop cooler features an ingenious movable-fan design for laptops up to 15.4 inches.



ITWIN, \$100

Simple design meets heavy encryption in the iTwin. Working as a wireless point-to-point link between any Internet-connected computers, the device allows sharing and editing without having to rely on open networks, cloud computing, or physical connections.



LEE VALLEY MINI-SPADE, \$7

This 9-inch stainless-steel spade suits both adventure activities and leisurely pursuits—take it on camping or canoe trips, or use it in the garden. The handle folds into the blade for storage in a nylon sheath that loops onto your belt.



STERIPEN FREEDOM, \$120

Make found water potable with the Freedom. The little device (5 inches and under 3 ounces) uses UV light to rid 99.9 percent of bacteria from a pint of water in 48 seconds. After 40 treatments, recharge the Freedom via its USB port.

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ABUSIVE LAB TEST

FLASHLIGHTS

M

Maglite set the standard for tough flashlights when it was introduced in 1979. Now Rayovac claims to make one that's **virtually indestructible**, and Coast and LED Lenser produce torches that outshine the Mag by a factor of 10. We punished one flashlight from each of the four manufacturers to find out which is the toughest. — STEVE ROUSSEAU



Rayovac, \$25
140 lumens

Maglite, \$55
131 lumens

Coast, \$295
1317 lumens

LED Lenser, \$306
1100 Lumens

SMASH THEM

We used the lights to pound 12 iron tent stakes into the ground.

Rayovac Emerged with minor scuffing, but the rubber end caps dampened the strikes.

Maglite The casing sustained shallow dents, but its D batteries produced heft for solid whacks.

Coast Failure! Major dents in the barrel prevented battery removal.

LED Lenser Using a \$300 flashlight as a hammer was delightfully perverse. Forty solid whacks only scratched the paint.

CRUSH THEM

We ran over the flashlights with a 1973 MGB.

Rayovac The rubber end caps popped off and the barrel suffered road rash, but it shone on.

Maglite Some minor scrapes served only to enhance the grip.

Coast You could barely tell a car had run over this thing.

LED Lenser Our driver peeled out and shot the flashlight 10 yards down the street. But it still lit up and suffered no structural damage.

DUNK THEM

Dropping a flashlight in a puddle or a lake is a possibility, so we submerged our subjects for 7 hours.

Rayovac After drowning for a full day, it still wouldn't quit.

Maglite The Mag isn't waterproof, but ours performed perfectly after the test dunk.

Coast It was shining after its soak, but water seeped in and fogged the lens.

LED Lenser It worked—even though water audibly sloshed around in the head.

UPGRADE

DROP THEM

We went bombs away with the lights onto concrete from a height of 25 feet.

Rayovac Hit the ground and bounced up like it was ready for more.

Maglite Big dent in the barrel but still shining.

Coast Sounded like a gunshot when it hit the ground—but suffered only scuff marks.

LED Lenser Still working, albeit with a deep scratch on the head.

BOTTOM LINE The Rayovac made a wimpy hammer but otherwise performed as well as the Maglite, which is twice as expensive but worth the investment for its sleek packaging and durability. If you're preparing for the apocalypse, the LED Lenser gets the call: a bright light, a resilient body, and great as a stand-in hammer. —S.R.



Cut this out.  Circle portions appropriate to your needs.

Get it in front of your loved ones. Or marginally liked ones.

Dear,
MOM, WIFE, GIRLFRIEND, AUNT, OTHER
(circle applicable)

As you know, (father's, my birth, because you love me, just another) day is right around the corner. I'd like to make shopping for me as easy on you as possible and avoid another (tie, golf accessory, monkey paw) which would ultimately end up (at the bottom of my closet, in a pond, unloved). Therefore, I have taken the liberty to provide you with this (foolproof, genius, best-gift-ever) suggestion, which will benefit us both greatly: I will get what I actually want; you will get a better version of me. Thank you in advance! (_____)
(sign here)

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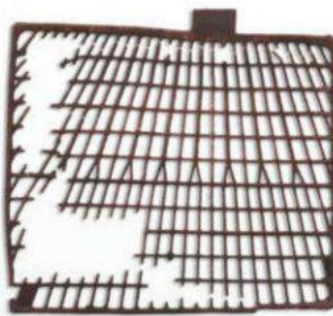
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1



2



3



4



5

UPGRADE

GEAR UP/ ROAD TRIP

Two yellow lines, long stretches of asphalt, and a big sky are the backdrop for happiness on wheels. Pack your emergency kit, atlas (you're going where GPS won't work), and these choice items to complete the picture. —JOHN BRANDON

1. GOPRO HERO2 MOTORSPORTS, \$300

With a 170-degree viewing angle, the Hero2 captures cockpit shenanigans or the road ahead for up to 6 hours of HD recording. Artsy types can snap 10 11-megapixel photos per second or one photo every half-second.

2. GRIFFIN SMARTTALK SOLAR, \$70

The sun charges this window-mounted, cableless speakerphone, which syncs with Bluetooth-equipped phones to enable hands-free calling. Plus, Griffin's free DriveSafe app provides info on local phone-use laws.

3. SCHWINN LOOP FOLDING BIKE, \$255

Nothing beats exploring a new town on foot—unless you happen to have a bicycle handy. The seven-speed Loop weighs 31 pounds and folds to the size of a suitcase. The aluminum frame and front steel fork are sturdy and big enough for a rider who's six foot four, and setup takes just 2 minutes.

4. OSPREY PORTER 65, \$129

The 2.3-cubic-foot compartment of this padded bag swallows a week's worth of clothing and gear. The ballistic nylon shell comes in black, red, or brown and has a large stowaway backpack harness and two zippered pockets.

5. BOXSAL PICNIC BOX, \$25

Old-school picnic sets: You use them once and then tag them for your garage sale. Instead, stuff 20 pounds of food and culinary accoutrements into the 20-inch-wide Boxsal—which includes bowls, trays, utensils, and cups for four—enjoy your vittles on the go, and then toss the 100 percent compostable set into a recycling bin.

ROAD APPS: 1. Trapster [free] helps you avoid police encounters, thanks to 15.5 million users who shared the location of 5.5 million speed traps. 2. Charmin SitOrSquat [free] locates and rates nearby bathrooms. 3. Roadside America [\$3] leads you to offbeat museums, monuments, and more.



HARDWARE STORE **We Love**

BY CATHERINE DENHAM

IN BUSINESS SINCE 1937**CLIENTELE**

Mostly local contractors but also fishermen, boaters, tourists, DIYers, and the just plain curious. The shop is co-owned by J.C. Strother's grandsons, brothers Gordon and Bill. "My grandfather loaned customers lumber and other goods that were hard to come by during the war," Gordon says. Strother carries on the tradition today, with more than 1000 house accounts on the books. And you thought good old-fashioned trust was a thing of the past.

LEAST-EXPENSIVE ITEM

Individual screws are sold at just 3 cents each, because, well, sometimes all you need is one screw.

CLAIM TO FAME

J.C. Strother Co. is best known for its selection of fasteners: The store dedicates almost an entire storeroom to 5000 types of nuts, screws, and bolts.

WHAT'S HOT

Strother is the go-to place for fishing tackle and beach necessities, from fishing poles, bait, and hooks to beach chairs, boogie boards, and umbrellas.

ODDBALL PRODUCT

Bill says customers clamor for Lee's Wood Corn Cutter, which shucks kernels from the cob. Bud Carter, a resident of nearby Harlem, Ga., and a Strother regular, purchases four or five each summer to create his famous creamed corn (sorry, secret recipe). "Bud calls it the best invention ever," Bill says. Summer visitors also flock to Strother to purchase the classic White Mountain wood-handled ice cream maker.

ODDS & ENDS**1941**

Year the store's elevator—the oldest one in Georgia—was put into service

2

Number of floors

12

Number of ceiling fans

1000+

Number of house accounts

2

Blocks from Atlantic Ocean

What's your favorite hardware store? Email us at popularmechanics@hearst.com.



J.C. Strother Co.,
St. Simons
Island, Ga.



✓Yes



✓Yes



✓Yes



xNo



✓Yes



✓Yes



✓Yes



✓Yes



✓Yes

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HOT RIDES

3

BEHOLD THE THUNDER GUN

WITH MILLIONS OF DOLLARS ON THE LINE, NASCAR PIT CREWS HAVE TO BE PERFECT. SO MUST THEIR TOOLS.

On a bright, sweltering Saturday afternoon at Talladega Superspeedway, in a shiny new Ingersoll Rand hauler located 20 yards from the Sprint Cup Series garages, pit crew tire changers trickle in and out, picking up or dropping off their scuffed yellow-and-black Ingersoll Rand Thunder Guns. Each man is met with a warm smile by Jim Hurd, the one person who knows their guns as well as they do.

"These are race-day-only guns," Hurd explains. "They have another set that they pit-practice with, and

JIM HURD
OWNER, HURD PIT TOOLS
THUNDER GUN SPECIALIST

"Half a second can cost you a million bucks."



DOWN THE ROAD

SEPTEMBER

GUTEN TAG

The 2012 Volkswagen Passat has been a hit in America. Now the diesel version is the newest member of our PM Fleet. **PAGE 48**

GUESS WHO

designed the 2012 Range Rover Evoque:
[a] Gerry McGovern
[b] J Mays
[c] Mark Adams
PAGE 49



➔ in one week they'll put on about the equivalent of five to six races. They practice every day."

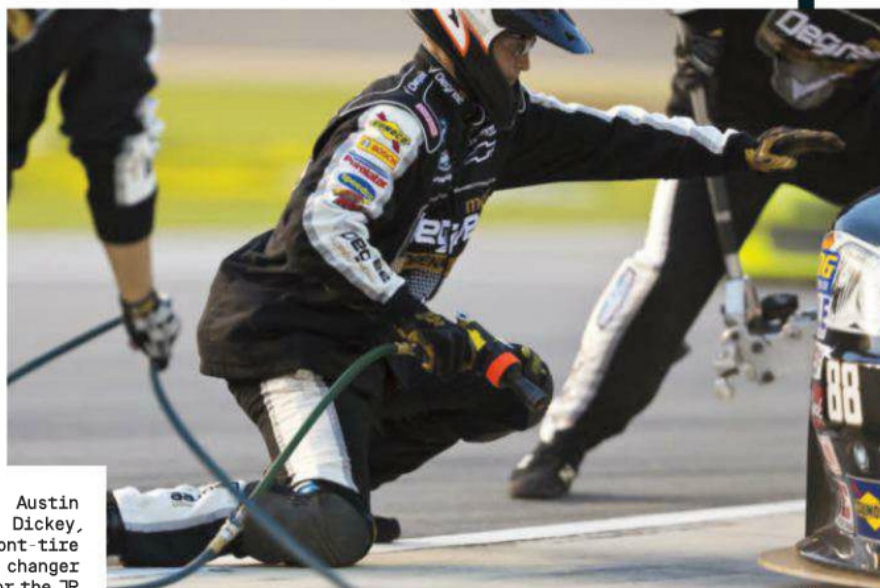
As the name suggests, the Thunder Gun is a powerful tool—a ½-inch impact wrench that uses 110 psi of nitrogen to produce roughly 1000 lb-ft of torque and 15,000 rpm. (A typical impact wrench runs at about 1800 rpm.) Ingersoll Rand sells the \$1500 gun exclusively to professional race teams. Hurd then customizes and scrupulously maintains the guns for the tire changers, making any number of adjustments depending on their preferences.

During a pitstop, the pit crew moves in a highly synchronized pattern based on the movements of the two tire changers. A Sprint Cup Series tire changer should take between 1.2 and 1.5 seconds to hit all five lug nuts. On average, that's 0.28 seconds per nut. A pit crew at the top of its game can change out two right tires in a mere 5.5 seconds and a full set in 12.5. It's a precision, high-pressure job where, as Hurd puts it, "half a second can cost you a million bucks."

The relationship between the Hurd family, Ingersoll Rand, and Nascar dates back more than 50 years. As Hurd tells it, his grandfather, Howard Hurd, was an Ingersoll Rand distributor and sold tools out of his VW minibus. In 1957, while watching the races on the sand during a family vacation in Daytona Beach, Fla., racers who needed repairs spotted him and his rolling tool shop; he was soon sold out. It was here that Howard first met Bill France Sr., the founder of Nascar.

The next year Howard and his van returned to Daytona for the races and sold out again. "Bill France Sr. comes over and says, 'Look, I'm building this track—Daytona Speedway,'" Jim Hurd says.

Austin Dickey, front-tire changer for the JR Motorsports No. 88 car, readies his Thunder Gun during a Nationwide Series race at Daytona International Speedway.



"I'd love for you to come down here and service these guys." Howard readily agreed. "Nineteen fifty-nine, he took his van, parked it in the garage, and we've been there ever since."

In the 1960s, Howard Hurd traveled the race circuit, servicing various stock Ingersoll Rand tools, including the 405, a pneumatic impact wrench. The modifying started when Glen and Leonard Wood of the Wood Brothers Racing team asked Howard if he could start supplying them with tweaked versions of the wrench. Back then, pitstops were slow-paced affairs—almost leisurely compared with today's standards. With souped-up tools and a rigorous pitstop ethic, the Wood brothers dominated. Soon pitstops became pivotal and Howard was in high demand.

Jim Hurd proudly carries on his grandfather's legacy. He's in his 28th year on the job and currently services the Thunder Gun, which was launched by Ingersoll Rand in 1998 with the help of Ray Evernham, Jeff Gordon's crew chief at the time. The guns are used by nearly all Nascar tire changers and can be modified in numerous ways.

For example: Nose cones can be steel, titanium, or carbon fiber (the last being the lightest). The gun's exhaust can be widened for improved airflow and higher rpm, and it can even be repositioned if needed (a front exhaust might blow brake dust in the gunman's face, or a side exhaust could spit oil onto the jackman or the tire carrier). And the resistance on a forward-reverse torque toggle can be adjusted (most Sprint Cup tire changers prefer high resistance to prevent an accidental switch).

Back at the hauler, people drop in just to say hi, and Hurd seems to know everyone around the garages by name. This could soon change, though. In two years, Hurd hopes to man a similar setup at a Formula One race in Europe. He's received some calls about a 1-inch gun for the single center bolts on their wheels, he says. But first he's got to get the setup perfect. There's a lot of racing over there. — ANDREW DEL-COLLE

AUTO INTEL



TIME SHAVER: If you watch a pitstop closely, you'll notice that tire changers don't waste time fiddling with any lug nuts. A few hours before the race, the lug nuts are bound to the wheels using weatherstrip adhesive, says D. J. Copp, a 14-year-veteran tire changer and now an Ingersoll Rand employee. When the gunman hits the bolt with a high-power impact wrench, the adhesive loosens, allowing the lug nut to rotate and securely fasten.

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TEST DRIVES

BASE PRICE: \$24,495
MPG (CITY/HWY): TBA

2013 Ford Focus ST



AUTO INTEL

It's turbocharged; it's got direct injection, sticky Goodyear Eagle tires, and a six-speed manual transmission. Yeah, it's fast going straight, but on the impossibly twisty Route Napoléon in the south of France, the 2013 Ford Focus ST really came into its own. The lively 252-hp 2.0-liter four-cylinder is all but lag-free, offering an abundance of torque in any gear, from 2000 rpm through 5000 (peak horsepower is at 5500), and that flexibility made it

easy to keep power on tap at all times. The Focus will even lift an inside wheel (à la Volkswagen's GTI) and rotate effortlessly, thanks to a beefed-up rear antiroll bar and redesigned knuckles out back. Fight a quarter-second of torque steer as you straighten the car and let the mechanical differential work with the electronic braking differential to find traction and, turn after turn, you feel like a tire-scorching hero. Where do we sign? — JAMES TATE

GLOSSARY

TORQUE STEER A pull to the left or right during hard acceleration. Occurs in front-wheel-drive vehicles where engine and transmission packaging results in the drive axles having different lengths. When power is applied, the longer axle requires more torsion to rotate, resulting in a slight delay.

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TEST DRIVES

BASE PRICE: \$22,725
MPG (CITY/HWY): 26/38



2013 Hyundai Veloster Turbo

The turbocharged 201-hp 1.6-liter four in this new Veloster boosts what was a poky base car into the affordable sports coupe bracket. And while the Veloster Turbo is quick, it's also manageable—you get diesel-like torque that pools in the basement (1750 rpm) and provides enough thrust to minimize the need for gear shifts on winding mountain roads. The car is reasonably quiet on the interstate too, since at 70 mph the Veloster Turbo's optional automatic (a six-speed manual is standard) allows it to loaf along at just 2400 rpm. And that

relative lack of revs helps it deliver high-30s highway mpg—but probably not at 70 mph. Although both cars use the same suspension tune, the normally aspirated Veloster's slightly stiff and busy ride appears to be minimized somewhat in the Turbo, thanks to an additional 217 pounds. The car also debuts what is perhaps the first application of a flat paint to a relatively inexpensive car. The color, matte gray, isn't cheap, though. It'll cost the Veloster Turbo buyer a cool \$1000, but we still dig it. — BEN STEWART

BASE PRICE: \$36,000 (EST.)
MPG (CITY/HWY): TBA



2013 Mercedes-Benz GLK

What's new: Two engines: a direct-injected V-6 that delivers better fuel economy and jacks horsepower from 268 to 302, and a 2.1-liter turbodiesel I-4 that offers better efficiency (and a mighty 369 lb-ft of torque).

What's excessive: This little ute gets auto start/stop, an antisnooze feature called Attention Assist, and electromechanical steering. And there's an optional auto parallel-parking feature—if that's your thing.

What's nice: The GLK will be good competition for the likes of the Audi Q5 and the BMW X3; it handles nearly as well as a C-Class sedan.

What's annoying: Moving the shifter from the center console to the steering stalk nixes the joy of intuitive manual-override downshifts. At least the wood-trimmed interior (a no-cost option) is slick.

AUTO INTEL

WHEELHOUSE

AUTO ODDS AND ENDS

150

Number of plastic-paneled delivery trucks UPS has ordered after successful field tests. According to the company, the lighter plastic body, which also allows for a smaller engine, improves fuel efficiency by up to 40 percent compared with the current aluminum-bodied vehicles.



The 2013 Dodge Dart's wireless phone-charging station.



Tonino Lamborghini's \$2743 gold-and-crocodile-skin-lined Android smartphone.



\$612M

Amount of money Verizon paid for Hughes Telematics, a major player in car-connectivity technology. The move is evidence that cars are the next frontier in wireless communications.

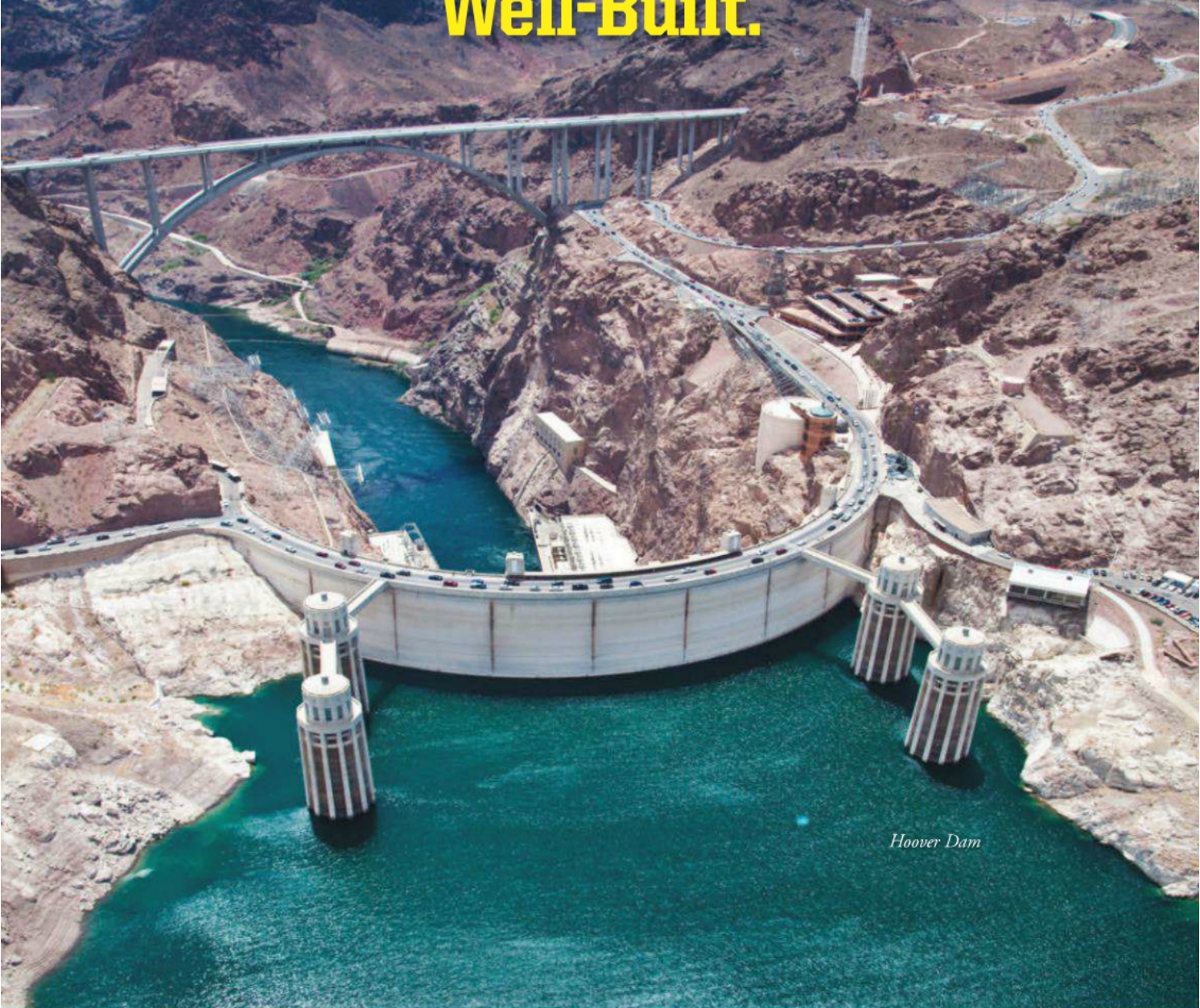


BRIGHT IDEA Nissan's Easy-Fill Tire Alert system, which signals when tire pressure is low and uses the vehicle's lights and horn to signal when the proper pressure is achieved, will come standard in all 2013 Nissan models.

The Highway Trust Fund, which refunds states for road, bridge, and mass-transit maintenance, is outspending its receipts. The HTF is largely funded by a federal 18.4 cents-a-gallon gas tax that was last increased in 1993. Either state spending must slow or the tax has to rise, but something has to give—not our bridges, we hope.



Well-Built.



Hoover Dam

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THE BENEFITS OF CERAMIC

It is common knowledge that companies like Ferrari, Mercedes, and BMW coat their high-performance engines in ceramic. High-end carmakers also offer ceramic brake systems and exhaust coatings in their high-revving, high-powered cars. The reason for this is clear: when you coat metal in ceramic it lasts longer. A ceramic-metal coating provides greater resistance to heat, friction, and engine wear. XADO ceramic treatments have been available in Europe for the past 15 years. **Isn't it about time you protected your vehicle's engine from the wear that occurs from every day driving?** By treating your car's engine and transmission with XADO Revitalizant you can reverse prior wear, and prevent future wear. XADO Revitalizant is a smart, self-regulating nanotechnology that rebuilds metal and protects it with a layer of ceramic-metal. Having a ceramic-metal coating inside your engine decreases friction during startup. This reduces engine wear and prolongs your car's life.

HOW DO I USE XADO IN MY CAR?



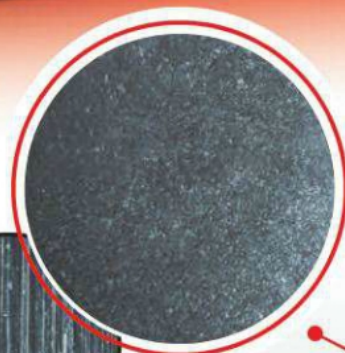
"Compared to other additives and treatments I like XADO the best because it actually made a noticeable difference in the way my car ran"

Just add XADO Revitalizant to your car's engine (oil crank case). Revitalizant uses the friction in your engine to repair scratches, gouges and wear and simultaneously form a diamond-hard protective coating in your car's engine metal. The interesting thing about Revitalizant is that the ceramic does not sit on top of the treated metal, but it actually penetrates the metal and forms bonds to become a semi-

permanent part of the engine metal. This is why Revitalizant is called a nano-technology, because it works at a molecular level. This coating lasts for 62,000 miles, so it does not need to be added over and over again.

↓ BEFORE application

The surface of the cylinder is covered with numerous scuffs and scratches.



100×

↑ AFTER application

The scratches, gouges, and wear have been repaired, resulting in a smooth, glossy surface. Revitalizant coats the engine's friction parts with a diamond-hard ceramic-metal coating. Not only has the metal been repaired, but it is now protected against future wear for up to 62,000 miles!

Restoration of worn surface after 888 miles (actual surface of the engine cylinder before Revitalization and after).

Substantial wear of even one vital engine part, such as cylinder walls, can result in malfunction throughout the entire engine. EX120 repairs and prevents this wear.



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 AUTO INTEL


BASE PRICE: \$33,900
MPG (CITY/HWY): 22/32



2013 Cadillac ATS

"All-new" is an overworked automotive descriptor, but this new rear-drive Caddy is about as close as it gets. There are some shared elements in its pedigree—the 202-hp 2.5-liter four is in the 2013 Malibu and other GM vehicles, and the 321-hp 3.6-liter V-6 is in the 2012 Caddy CTS, for example—but the vehicle itself began on a blank computer screen. Benchmarked against BMW's 3 Series, the dominant compact luxury sport sedan, the ATS unibody represents attention to rigidity and weight reduction bordering on obsessive. The structure is a complex combination of high-strength steel, aluminum, and magnesium, unified by extensive spot welds, seam welds, rivets, and industrial adhesives. The body shell is up to 40 percent stiffer than that of Cadillac's CTS, resulting in some impressive cornering prowess. Our drive on Georgia byways and at the new Atlanta Motorsports Park showed the ATS to be a strong challenger in this German-dominated class. It's most fun to drive with the all-new 2.0-liter turbo (272 hp) paired with the six-speed manual transmission and a special sport suspension, but even the basic ATS rewards the driver. — **TONY SWAN**

BASE PRICE: \$35,350
MPG (CITY/HWY): 22/32



2013 GMC Terrain Denali

What's new: GMC Denali-izes the Terrain. That means cabin upgrades such as mahogany panels; a soft-touch, French-stitched instrument panel; and an eight-way power passenger seat. Outside, you get satin-chrome trim.

What's good: A 3.6-liter direct-injection V-6 makes 301 hp, a 14 percent bump versus the outgoing 3.0-liter, with no loss in fuel economy. Base editions get a 182-hp 2.4-liter four.

What's clever: Dual-rate shocks at the front corners incorporate secondary pistons: Hit a small bump and they stroke softly for a smooth highway ride. Plow hard into a corner and a secondary valve blocks the normal flow of hydraulic fluid, stiffening the ride for sharper handling.

What smarts: A full-boat Denali-edition GMC Terrain will run you north of \$42,000, or 10 bucks per pound.

3-YEAR LEASE: \$36,625
MPGE (MIXED): 118



2013 Honda Fit EV

TEST DRIVES

onda is dipping a cautious toe into the EV pool. The new Honda Fit EV will be offered only as a three-year lease in California and Oregon at first. Too bad, because it's one of the most entertaining EVs around—even if it does come in just one flavor: painted Reflection Blue Pearl and fully loaded. In place of the engine is a 92-kilowatt electric motor fed by an air-cooled 20-kwh Toshiba lithium-ion battery pack good for a cruising range of 82 miles. It can be fully charged in 3 hours using a 240-volt charger, but the battery eats up 8.6 cubic feet of cargo space. With a full 189 lb-ft of torque behind it, the new EV leaps off the line. A three-mode system (Econ, Normal, Sport) doles out the power and adjusts throttle response at the push of a button. Sport mode is exceedingly entertaining to drive in, though on our short jaunt in the hills around Pasadena, Calif., Econ was largely sufficient. That's because the torque output of the electric motor never changes. Under most circumstances this EV handles just like the frisky gasoline Fit we have always adored. And that's a very good thing. — **BEN STEWART**



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PM FLEET

CARS WE LIVE WITH

2012
VW PASSAT
TDI SE CLEAN
DIESEL
•
FIRST
REPORT

Aiming to double its U.S. sales by 2018, Volkswagen has focused its efforts on designing cars specifically for Americans. So far, they're spot on. The 2012 Passat sacrifices some of the last model's obsessive attention to detail in exchange for a more spacious, affordable, and fuel-efficient vehicle that's proved wildly popular. For us, the most alluring model is the diesel version,

the only midsize, midprice diesel sedan available in the States. The turbo TDI is no valve-rattling powerplant of diesel yore; it's smooth and quiet and, paired with a twin-clutch six-speed automatic, it delivers a ton of torque that gooses the Passat up the on ramp ("serious zip," one driver enthused). There's also plenty of fast-twitch muscle for Manhattan lane jockeying. Yet our stylish steely-blue-gray Passat sips the low-sulfur diesel—a tank seemed to last forever on road trips up to Cape Cod or down to Maryland's Eastern Shore. The cabin gets high marks for the limo-grade legroom front and back, and interior appointments—brushed metal trim, leatherette seats—show elegant restraint. PM staffers like the precision steering, minimal body roll, and pothole-smoothing suspension on city streets. Overall, we can't wait to put some more miles on the odo—especially in Sport mode. — **DAVID DUNBAR**

DRIVERS NOTEBOOK

- Maybe a college degree isn't what it used to be, but two staffers couldn't figure out intuitively how to turn off the radio and still keep the nav map up on the screen.
- Simple single-knob functionality makes it easy to operate the sunroof while keeping your eyes on the road.

VITAL STATISTICS

BASE PRICE/AS TESTED
▶ **\$25,995/\$30,265**

EXTRA-COST OPTIONS
▶ **Sunroof, navigation**

POWERTRAIN ▶ **140 hp, 236 lb-ft; 2.0-liter turbo I-4; 6A, FWD**

EPA FUEL ECONOMY (CITY/HWY/COMBINED)
▶ **30/40/34**

MILES DRIVEN ▶ **2834**

PM FUEL ECONOMY ▶
Average: 37.9 mpg
Best: 41.2 mpg
Worst: 30.2 mpg



NEXT MONTH: 2012 BUICK REGAL GS, 2012 BMW 328i

AUTO INTEL



ENGINE OF THE MONTH

FORD 1.0-LITER ECOBOOST

WHEN IT COMES TO INCREASING ENGINE EFFICIENCY, the low-hanging fruit has long been picked. Saving more fuel requires finer innovations, with modest results. Take Ford's new turbocharged 1.0-liter three-cylinder engine. The tiny mill maximizes fuel energy by combining small size with an exhaust-driven pump that adds in more air (and fuel) when needed. That's the recipe used by all of Ford's EcoBoost engines. But the 1.0-liter adds several ingredients, mostly to reduce friction. The crankshaft, for example, is slightly offset from the cylinders so the power stroke doesn't drive the crank bearings hard into the journals. And there's a split-cooling system that Ford says reduces the time for cold, thick oil to heat up. The exhaust manifold is cast into the head, saving a few pounds. The tweaks are small, but when the engine lands in the Fiesta next year, the car's fuel economy should jump about 15 percent to somewhere in the mid-40s on the highway. And that's with roughly the same power and torque as the Fiesta's current 1.6-liter engine. — **LARRY WEBSTER**

PHOTOGRAPH BY GREGG DELMAN (VW)



THREE IS ENOUGH, MAYBE

DRAWING BOARD

GERRY MCGOVERN, LAND ROVER DESIGN DIRECTOR

After stints at Ford and Lincoln, Gerry McGovern faces his biggest challenge: pulling Land Rover into the future without being shackled by its illustrious past. These are some of his thoughts on car design, the stunning Range Rover Evoque, and retaining heritage while avoiding the retro trap. — LARRY WEBSTER

"Great design is nothing without engineering integrity. And engineering integrity is nothing without great design."



People say to me, "Oh, this DC100, it's gone too far." And I say, "What do you mean?" "Well, it should look just like the old [Defender]." What's the point of that? Why design a vehicle that looks like it was designed 60 years ago?



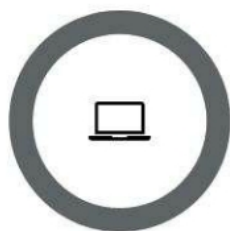
○ **I THINK DESIGN** is becoming more and more important because once technologies become comparable from one brand or one company to another, once engineering becomes comparable, once quality, reliability, they almost become givens . . . Design is now very much the key differentiator, since it resonates on an emotional level.

○ **I DON'T BELIEVE** you can ever design by committee. If you listen to too many points of view, you'll end up with mediocrity. If the Evoque failed and didn't sell because it was seen as an ugly vehicle, I'm the one who gets fired.

○ **AFTER WE DID** the Evoque concept car [called the LRX] in 2008 and decided to put it into production, the engineers said, "To get the suspension travel that we want for off-road capability, the car needs to sit higher off its wheels. To get really competitive rear cargo room, you need to lift the roof." But the great thing about the LRX and now the Evoque is that it's got killer proportions, and first and foremost you have to get the proportions right—wheel at each corner, falling roof, dramatically rising belt line, good body side section. It looks like it's planted.

○ **SO I SAID**, we're not doing any of that. I put the onus back on the engineers: Be creative and figure out how to keep the concept-car design. And they did. The production Evoque changed very little from that original concept.

○ **NOW WE'RE WORKING** on the next generation of Land Rovers, like the Range Rover. That vehicle has to have certain design cues—a floating roof, a clamshell bonnet [hood], short overhangs, high sills, and a relatively equal glass-to-body relationship. How do you modernize those design cues? If you go too far, you'll be perceived as generic and you'll fail. If you don't go far enough, you'll be seen as retro, and that's the kiss of death. Recognize your past, but don't be harassed by it. **PopMech**



Man With a Plan

BY ALEXIS
OHANIAN,
AS TOLD TO
WOOK KIM

ADVICE FROM THE REDDIT
CO-FOUNDER ON HOW
TO MAKE SOCIAL MEDIA
WORK FOR YOU.



Alexis Ohanian, 29, is a digital-media wunderkind but still enjoys quality time with a newspaper.

🕒 **The reason people need advice on using social media** is that they're a much more complex and nuanced way to communicate than a conversation or email.

🕒 **I started learning about this complexity** when I was a teenager. I used to go online and use the Microsoft Comic Chat program, which had an interface like a cartoon storyboard. You'd choose an avatar and chat with people via comic-strip speech bubbles. That was my introduction to the Web and, in a way, to social media. I was in awe! I was talking—as a cat—to random strangers.

🕒 **The social-media landscape changes incredibly fast, so you have to be open-minded and nimble** to keep up with it. In 2005, eons after I was a talking cat, I founded Reddit with my fellow University of Virginia graduate Steve Huffman. We wanted to create a front page for the Web. No avatars there—just pure social media, providing a way for people to share and discuss stories that interest them.

🕒 What I learned in the span between Comic Chat and Reddit is that **in the social-media world, "personal" and "brand" are very closely linked**, and that building a business based on social media is really just a strategic application of your personal and brand identities.

🕒 I have a MacBook Pro and a MacBook Air—I don't go many places without a laptop—and I have a Galaxy Nexus. In other words, like a lot of people today, I can jump online in an instant. **It takes discipline not to let social media steal your time.** I use them on aggregate about 2 hours a day. My preferred plat-

form is Reddit—surprise! But I use software called RescueTime to kick me off after an hour. And I maybe spend up to another hour on platforms like Facebook, Twitter, and Google+.

🕒 One effective way of curbing your dependence on social media is to **build time into your day where you're totally offline.** I call



that time girlfriend time. I live on the East Coast now, so the first few hours in the morning work especially well, since everyone in the West is still asleep.

Being effective at social media, whether for business or personal use, means capturing people who have short attention spans. They're only a click away from a picture of a funny cat, so you have to make your thing more compelling than that cat. And that can be a high bar.

This idea connects to my first rule of developing a social-media strategy: Make sure your product or service or cause is something people want. It's all about creating quality content. Maybe you can spam your way to short-term success, but that approach won't work long-term.

Second rule: Understand the importance of being candid and transparent. There's a cliché about crisis being an opportunity, but when you do screw up—which shouldn't be too often—think of that screwup as a chance to show that you give a damn, that you are invested in your product or content. By admitting your mistakes and doing whatever it takes to make things right, you can win people over and even gain new users. The way you treat your users or customers, and how you personally present yourself through social media, is a way to differentiate yourself from your competitors.

Third rule: You cannot be less than 100 percent committed. Hard work and hustle are just as important as the thing or idea you're trying to sell. Anything you post must have a purpose. And you have to be relentless about engaging your users, your fans, your customers—respond to every tweet, comment on every blog post. This makes sense not only as a way to get a better understanding of your users, but you also never know if one particular response is going to go viral.

That said, using **social media is not a popularity contest.** Sure, it's nice to be noticed by a big audience, but that's not the most important metric. What matters is not the number of followers, subscribers, or whatever the equivalent. You want to get a feel of engagement, sentiment, and user morale. All of those are almost impossible to quantify. But anyone who pays attention to the conversations of their community will get a feel for these things.

Start by making your customers or followers happy—they'll end up doing all the social-media magic. We had one Redditor (that's shorthand for Reddit user) who was corresponding with a well-known hotel chain. He jokingly requested that his room be prepared with a bathtub full of Reese's Pieces and a bed full of puppies. This person arrived at the room to find a bag of Reese's Pieces and a handwritten note with an enclosed picture of a kitten. It was a small gesture—maybe cost the hotel just a few dollars—but it was a gesture of the emphasis the hotel puts on customer care. The Redditor wrote about the incident, and it made it to the front page, where it was read by hundreds of thousands of people and linked to blogs everywhere. So in pursuing their mission of delivering a great customer experience, this hotel chain ended up with more exposure and goodwill than a very expensive ad campaign could provide.



5 THINGS YOU SHOULD NEVER DO WHEN USING SOCIAL MEDIA

[1] Talk to people any differently than you would if they were right in front of you.

[2] Feed the trolls.

[3] Engage in shameless self-promotion. Better to post positive things about other people's work and then let the good karma work for you.

[4] Drink to excess. [If you do, disconnect from the Internet.] An inebriated slip of the thumb on your Twitter feed can do major damage.

[5] Be mean to @MollyRingwald. Seriously, she's a big fan of Reddit, and she's very nice.

Ignore what your competition is doing. Shortly after we launched Reddit, we found out about another social-news site, Digg. We realized that what your competitors do should be irrelevant. Stay focused on your own plans and strategy. More often than not, what can ruin a business isn't what a competitor does, but rather something that happens internally. When we started Hipmunk, a travel site, we were well aware of Kayak. We didn't focus on being better than them. We just set about creating what we thought would be the best travel search site. This single-minded focus can be applied to almost every venture on the Internet.

Is there a real importance in creating a unique online identity? Well, I don't want to get into this whole way of thinking that everyone is his or her own special snowflake [laughs], but I've found that if you are true to yourself and your product or idea, the differentiation will grow almost organically. And from differentiation comes success.

The social-media landscape today is very different than the one we faced when we launched Reddit. It was successful because it preceded this flood and stood out as something unique. Starting Reddit today would be much harder, but there are so many more ways for great ideas to spread online now.

So you have to keep in mind, success very rarely happens overnight. For those who use social media strictly for personal reasons, success is defined as engaging with people and communities you really care about. Regardless of your social-media goals, have patience and temper your expectations. Things need time to blossom, so you have to resist the urge to change tactics and embellish your plans. There's beauty and strength in simplicity and clarity. **PopMech**



Don't Ask Glenn

BY GLENN
DERENE

PAY-BY-PHONE: SMART,
CONVENIENT—AND
INHERENTLY UNFAIR.

How would you like to pay for your morning coffee: cash, credit, debit, or phone? In the near future, this may not seem like such an unusual question.

In fact, I'm willing to bet that instant pay-by-phone will become common in three years. And the way the tech is implemented could have a major impact on commerce in America—in a way that should make us all take pause.

Several competing systems have already emerged. Google Wallet and Isis use an embedded near-field communication (NFC) chip that is essentially a radio-frequency identification (RFID) antenna; PayPal and Pay with Square operate via an app that authenticates purchases in the cloud. All of the systems link your phone to your bank or credit card account and are used to authorize a transaction on the spot.

The technology raises some tough issues, the thorniest of which are fueled by the smartphone itself. The device has three

qualities that, when combined, make it unlike any other transactional agent: It has a screen, it is location-aware, and it's connected to the Internet. Throw those ingredients into an ordinary purchase and things can get wacky. Consider pricing, for instance. What should a cup of coffee cost? Should the cost differ for a frequent customer and a new one, or at 8:30 am and 7:30 pm? What if two coffee shops could bid for your business? Each phone's screen could display a price based on the user's profile, location, and current inventory of the product for sale. Ultimately, pay-by-phone could render sticker prices meaningless and turn customers into commodities that retailers bid for with targeted discounts.

While it's true that services such as Groupon and LivingSocial have already established discount-based economies, smartphone transactions would add another dimension by making algorithmic haggling part of the buying process. A version of this already exists online. In June, the travel site Orbitz revealed that it automatically showcases more expensive booking options for Mac users than it does for PC users, based on research showing that Mac users on average spend \$20 to \$30 more a night on hotels than their PC counterparts.

Orbitz customers can sort their booking options by price, so one could argue that there's nothing pernicious about the company's digital profiling of customers. But pay-by-phone could take this a step further. Your smartphone tracks where you go, handles much of your social networking, holds detailed information about your personal and business contacts, and logs whom you've communicated with and when. Now layer onto that a detailed transaction history and you've got the world's most sophisticated customer-targeting device.

Isis, which is backed by several cellular and credit card companies, plans to bundle loyalty cards, debit cards, and credit card accounts into a mobile-payment app. Manas Mohapatra, an attorney with the Federal Trade Commission's mobile technology unit, sees how this could benefit consumers by saving them money but also lead them to unwittingly release personal data. "If you subvert consumers' expectations, that's problematic," he says. "Are they being made aware when they're entering into a new transaction with a new entity? Are third parties that consumers think are ancillary to the transaction getting information?"

Technology itself is neither good nor bad, but the behavior it enables is open to debate. Mobile payment systems have the potential to create a profoundly undemocratic economy. Nobody said capitalism was fair, but if preferential pricing goes to those with the latest high-tech tools, the least fortunate citizens end up paying more for everything. And even those who can participate in smartphone commerce will be forever peeking at the screens of others, wondering who got a better deal. **PopMech**



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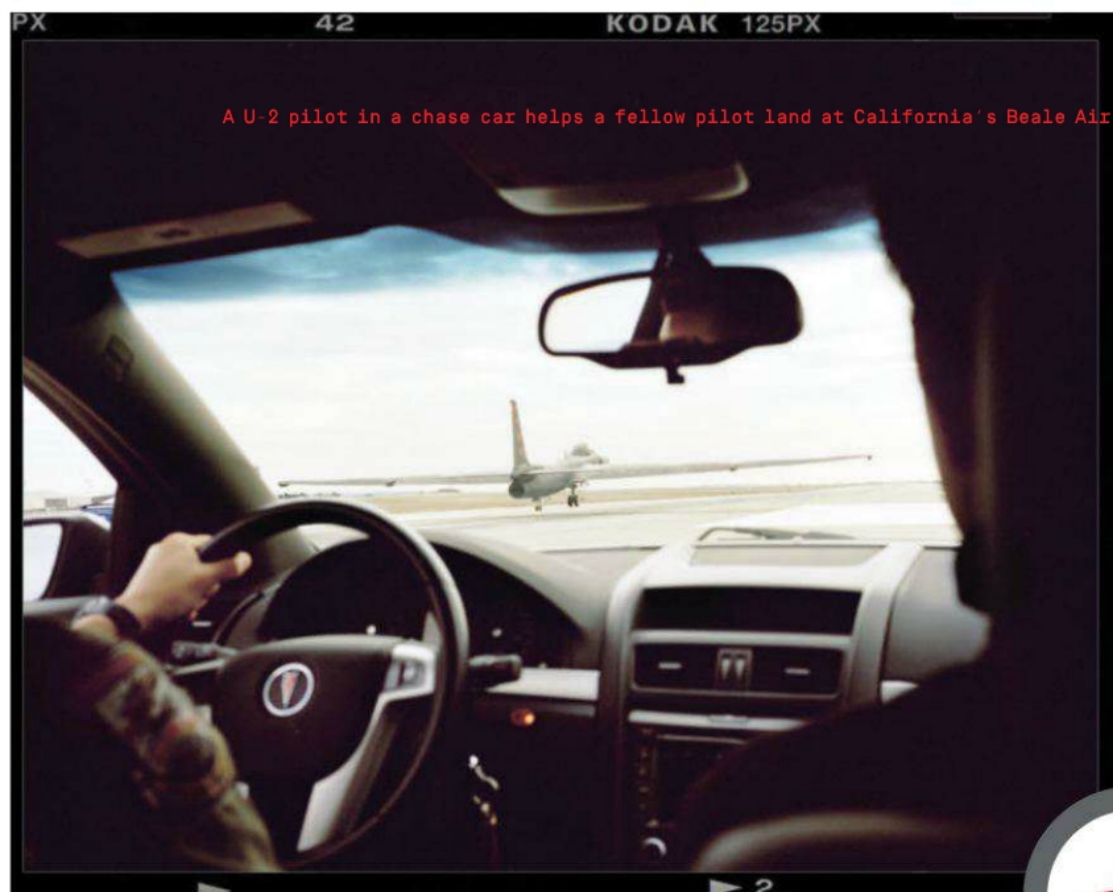
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Chasing the Dragon Lady

BY SAM
SMITH

THE U-2 SPY PLANE HAS BEEN GLEANING SECRETS FOR MORE THAN 50 YEARS. A KEY TO ITS LONGEVITY: EVERY LANDING TURNS INTO A HIGH-SPEED PURSUIT.

On this overcast morning, I'm in a blue Pontiac GTO parked by the runway at Beale Air Force Base near Sacramento, Calif. Major Tony, a U-2 pilot (last name withheld for operational security), is at the wheel, telling tales of botched landings.

There's no shortage of material: Setting down a U-2 requires a deft touch. The plane's tricky landing dynamics are a fundamental byproduct of its design. Long, thin wings and a short, needle-like body provide the high lift and low drag necessary for what pilots casually call high flight—U-2s commonly cruise above 70,000 feet, twice as high as a commercial airliner—but they cripple low-speed handling. And the center-mounted landing gear, configured to reduce weight, means the plane sets down like a flying bicycle.



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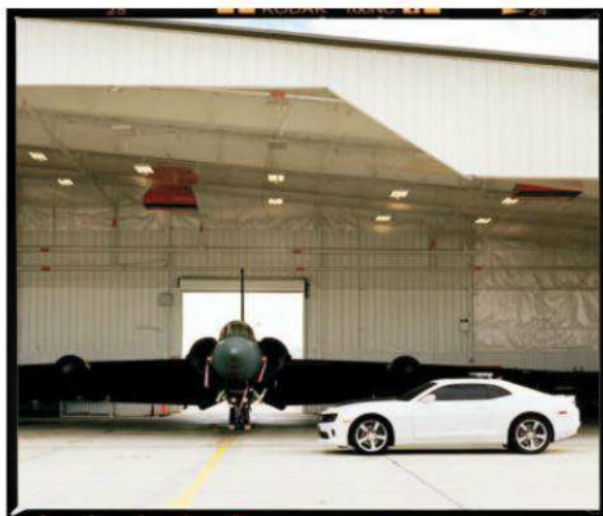
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What's more, pilots wear constrictive pressure suits and fishbowl helmets with plexiglass visors that limit peripheral vision. The cockpit is cramped, restricting visibility; the controls are not hydraulically assisted and are painfully heavy at the plane's 80-to-90-mph landing speed. "Aside from simply landing the aircraft and controlling your centerline pitch, you have to fly the wing level," Maj. Tony says. "So you're wrestling your arms back and forth the entire time just to keep the wingtips from touching the ground. It's a nonstop game."

All that has earned the U-2 the distinction of the most difficult aircraft to fly in the U.S. Air Force. In 57 years of operation, just 920 pilots have been certified to fly what is nicknamed the Dragon Lady.

Because the spy plane's pilots are so taxed, the Air Force long ago mandated that chase cars driven by U-2 pilots follow the craft for landings, talking the pilots through touchdown. The chase cars typically have powerful, torquey engines—in addition to the GTOs, the fleet includes Pontiac G8 GTs and Camaro Super Sports—largely because these can launch from a standstill to landing speed in roughly a quarter-mile.

The drivers, known as mobile pilots, race behind the planes as they land, radioing reports on altitude and attitude. "You can't get too close to the plane

or you'll burn the paint off the hood," Maj. Tony says, "but too far and you're not much help to the pilot." The preferred position: three car lengths behind the tail and slightly to the side to avoid the wash of the U-2's 17,000-pound-thrust turbofan.

On this day of go/no-go weather, the primary chase car is a Pontiac GTO; Maj. Tony and I are following in another GTO, which has been driven hard. The doors are dented and the nose is faded and specked with rock chips. The upholstery is frayed, the plastic door panels are scratched, and dash trim fits poorly. A VHF/UHF radio is installed in the car; the control box and microphone are on the console.

About 10 minutes after we park near the end of Beale's 12,000-foot-long runway, the first aircraft of the day appears in the distance. I've been around planes all my life—my father was a flight instructor when I was a boy—but I've never seen anything in the air like a U-2. It has a birdlike elegance that's missing from contemporary military aircraft. It looks like a giant gull with waving wings.

This one is a two-seat trainer with tandem canopies. It floats in from the left and banks in a long, sweeping arc. When it's almost on top of us, the primary chase car guns it; Maj. Tony follows a short distance behind. By the time we roll onto the runway we're doing about 80 mph. The major is pilot cool, driving casually with one hand on the wheel and the other on the radio mic.

The plane flies overhead, clearing the roof panel of the primary car by what seems like inches but is probably a few feet. It suddenly fills our windshield, a jinking, floating sea of matte black. Over the radio we hear the primary driver spew a steady stream of data to the pilot on landing-gear height and roll angle as both cars rip down the tarmac, throttles floored, exhausts blaring.

When the U-2 is about 2 feet above the runway, the pilot holds off until it stalls, and the plane slams onto the deck, tail wheel first. Heat pours out of the tail and makes the tarmac shimmer. We're so close that I have a straight line of sight up the plane's exhaust; the GTO reeks of jet fuel, as if someone had spilled the world's largest Zippo in my lap.

But this is just a practice landing: After coasting for a few seconds, the pilot throttles up again and the U-2 takes off seemingly vertical, rapidly gaining altitude in a 30-degree climb. The chase cars slow and then return to their positions at the end of the runway for the next touch-and-go.

Above left: An instructor and a pilot in pressure suits talk after a flight in a U-2 trainer as maintainers perform post-flight inspections. The Camaro SS chase car in the hangar is a 2011 model; the current U-2 airframe dates from the 1980s.

Chicago Doctor Invents Affordable Hearing Aid Outperforms Many Higher Priced Hearing Aids

Reported by J. Page

CHICAGO: A local board-certified Ear, Nose, Throat (ENT) physician, Dr. S. Cherukuri, has just shaken up the hearing aid industry with the invention of a medical-grade, affordable hearing aid. **This revolutionary hearing aid is designed to help millions of people with hearing loss who cannot afford—or do not wish to pay—the much higher cost of traditional hearing aids.**

**"Perhaps the best quality-to-price ratio in the hearing aid industry" – Dr. Babu, M.D.
Board Certified ENT Physician**

Dr. Cherukuri knew that hearing loss could lead to depression, social isolation, anxiety, and symptoms consistent with Alzheimer's dementia. **He could not understand why the cost for hearing aids was so high when the prices on so many consumer electronics like TVs, DVD players, cell phones and digital cameras had fallen.**

Since Medicare and most private insurance do not cover the costs of hearing aids, which traditionally run between \$2000-\$6000 for a pair, many of the doctor's patients could not afford the expense. Dr. Cherukuri's goal was to find a reasonable solution that would help with the most common types of hearing loss at an affordable price, not unlike the "one-size-fits-most" reading glasses available at drug stores.

- **Designed By A Board Certified Ear, Nose and Throat (ENT) Doctor**
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He evaluated numerous hearing devices and sound amplifiers, including those seen on television. Without fail, almost all of these were found to amplify bass/low frequencies (below 1000 Hz) and not useful in amplifying the frequencies related to the human voice.

Inspiration from a Surprising Source

The doctor's inspiration to defeat the powers-that-be that kept inexpensive hearing aids out of the hands of the public actually came from a new cell phone he had just purchased. **"I felt that if someone could devise an affordable device like an iPhone® for about \$200 that could do all sorts of things, I could create a hearing aid at a similar price."**

Affordable Hearing Aid With Superb Performance

The high cost of hearing aids is a result of layers of middlemen and expensive unnecessary features. Dr. Cherukuri concluded that it would be possible to develop a medical grade hearing aid without sacrificing the quality of components. The result is the MDHearingAid PRO®, starting well under \$200. **It has been declared to be the best low-cost hearing aid that amplifies the range of sounds associated with the human voice without overly amplifying background noise.**

Tested By Leading Doctors and Audiologists

The MDHearingAid PRO® has been rigorously tested by leading ENT physicians and audiologists who have unanimously agreed that the **sound quality and output in many cases exceeds more expensive hearing aids.**

DOCTORS AND PATIENTS AGREE: "BEST QUALITY SOUND" "LOWEST AFFORDABLE PRICE"

"I have been wearing hearing aids for over 25 years and these are the best behind-the-ear aids I have tried. Their sound quality rivals that of my \$3,000 custom pair of Phonak Xtra digital ITE"—Gerald Levy

"I have a \$2,000 Resound Live hearing aid in my left ear and the MD HearingAid PRO in the right ear. I am not able to notice a significant difference in sound quality between the two hearing aids."

— Dr. May, ENT physician

"We ordered two hearing aids for my mother on Sunday, and the following Wednesday they were in our mailbox! Unbelievable! Now for the best part—they work so great, my mother says she hasn't heard so good for many years, even with her \$2,000 digital! It was so great to see the joy on her face. She is 90 years young again."—Al Peterson

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THE U-2 IS A GLIMPSE into another era, a relic of an age when jet flight was the nation's bleeding-edge tech frontier. It's also a genuine piece of history: John F. Kennedy viewed images taken from a U-2 immediately before the Cuban missile crisis. Pilot Francis Gary Powers famously was shot down in one over the Soviet Union, sparking an international incident. That the Lockheed's relatively simple airframe, designed during the Eisenhower administration, is still in use today is a testament to its genius.

Drawn up before the age of surveillance satellites, the U-2 was originally meant to fly above 1950s ground-based defenses. As a result, it cruises in the wispy veils of the upper atmosphere. U-2 pilots look up at noon on a sunny day into the inky void of space. They fly without a wingman or co-pilot for up to 12 hours at a time. They're high enough to view the earth's curvature with the naked eye, and disorienting decompression sickness—what deep-sea divers call the bends—is a very real threat following long flights.

Why expend so much effort for what is effectively a satellite's view of the world? It's a common question, and there's no easy—or at least unclassified—answer. All the Air Force will say is that satellites can't always be where you want them, and they can't talk to soldiers on the ground.

"The U-2 is a very simple, very light, very brilliant design," says Lt. Col. Steve Rodriguez, a U-2 pilot and one of the commanding officers at Beale. "Its [main] advantage over a drone is weight-carrying capacity—3000 pounds at altitude. It's got a great generator, so it can run a lot of equipment, which drones can't. You can miniaturize stuff all day long, but if you don't have enough power to run that radar antenna, then it isn't gonna get run."

Technical updates have kept the plane relevant, and its relative fuel efficiency keeps operating costs low. The U-2's current wet-film camera, an SR-71 Blackbird hand-me-down, offers greater resolution than anything digital. A datalink allows pilots to send information to ground troops in near real time. Given today's technology and each flight's inherent danger, it's amazing that this remnant of a bygone age still sweeps the skies.

"It provides something you can't get from any other airframe," Maj. Tony says. "All it takes on a 60-to-90-day deployment is that one time when the ground troops come back and say, 'Hey, you just saved this many lives.' That makes the deployment, and it happens all the time."

AFTER THREE RUNS in the chase car, the smell of jet fuel is overwhelming. I almost feel it condense on my skin, and the air takes on an oily thickness that makes it hard to focus my eyes. Maj. Tony is used to it, but I'm ready to puke.

On the final chase of the day, the trainee lands and begins braking. The plane slows, holds vertical for a second, and then flops onto its left wing, dragging the tip (it's protected by a titanium skidpad) while coming to a stop. A truck rolls out onto the runway, and the crew jumps out to insert detachable auxiliary wheels, called pogos, into sockets at midwing, one wing at a time. (The pogos assist the plane on takeoff but are left on the tarmac once the plane is airborne.) Rain begins to fall as the U-2 taxis back to the hangar, which seems to mildly disappoint Maj. Tony. "Doing run-ins in the rain is fun," he says. "You get pretty good at drifting." **PopMech**



5 THINGS YOU MAY NOT KNOW ABOUT THE LOCKHEED U-2

[1] The CIA ran the early years of the U-2 project. Pilots who transferred in from the Air Force simply disappeared one day, or in Pentagon terminology, "evanesced."

[2] The Air Force says the U-2's range is more than 5000 miles.

[3] The resolution of the decades-old wet-film camera is sharp enough to see roadside bombs from 70,000 feet.

[4] As part of the evaluation process, pilot candidates are asked to wear the U-2 pressure suit and sit in a corner in a dark room for an hour to ensure that they're not claustrophobic.

[5] Although the military won't confirm or deny it, knowledgeable sources claim that the majority of visual intelligence in the war on terror comes from U-2 flights, not drones or satellites.

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big



The economy may be struggling, but there is still plenty of work to be done in America. Aging bridges need to be replaced, ships need building, energy needs to be produced, and one famously wounded skyline needs to stand tall again. Most of the building projects in this country are small operations. These 10, however, are monumental undertakings. Some are unquestionably necessary; others are controversial. But each one is a challenge to the idea that we don't build big things anymore.



When completed in 2013, One World Trade Center (aka Freedom Tower) aims to be the tallest structure in the Western Hemisphere, with 3.5 million square feet of interior space.

ONE WORLD TRADE CENTER

FROM THE TOP OF THE HOUSE, as construction workers at One World Trade Center call it, the view on a clear day extends deep into neighboring Connecticut and New Jersey and out into the Atlantic Ocean. It's just days after the building surpassed the 1250-foot-high roofline of the Empire State Building, and there is a debate swirling between the lead architect, David Childs, and the Port Authority of New York and New Jersey, which owns the site, about the design of the antenna mast, which may or may not qualify One World Trade as the tallest building in the Western Hemisphere at 1776 feet when complete. The ironworkers here are focused on floor 96, installing rebar as thick as tree limbs to form the tower's reinforced concrete core, the "building within a building," according to Port Authority director of WTC construction Steve Plate. "The core walls aren't sheetrock like the original towers, they're more than 6 feet of concrete in places. We're rewriting the book on security for office towers."

One hundred floors below, crowds gather near the young oak trees and twin waterfalls of the 9/11 Memorial. The memory of nearly 3000 lost here a decade ago is never far from mind at the World Trade Center site—not for the workers with NEVER FORGET stickers on their hardhats or the designers of the crowning, chamfered replacement for the Twin Towers. "Not many office buildings have been attacked twice by terrorists," says Port Authority executive director Patrick Foye, referring both to Sept. 11, 2001, as well as the bombing of the north tower in 1993. "This tower is a bold symbol of recovery from that."

After consultation with the CIA, FBI, New York Police Department, and security firms, designers implemented a raft of safety measures—including extra-strong fireproofing, redundant water tanks at the top and bottom of the building to feed sprinkler systems, and biological and chemical filters in the air-intake system. Then there is the massive "podium" that forms the building's base—a concrete slab 187 feet tall and 200 feet wide.

Inside the reinforced core, designers plan for egress stairwells almost one and a half times wider than code, an additional stairwell for first responders, and a fireman's

lift leading to a pressurized fireman's lobby. "The core is basically an isolated bunker," Plate says.

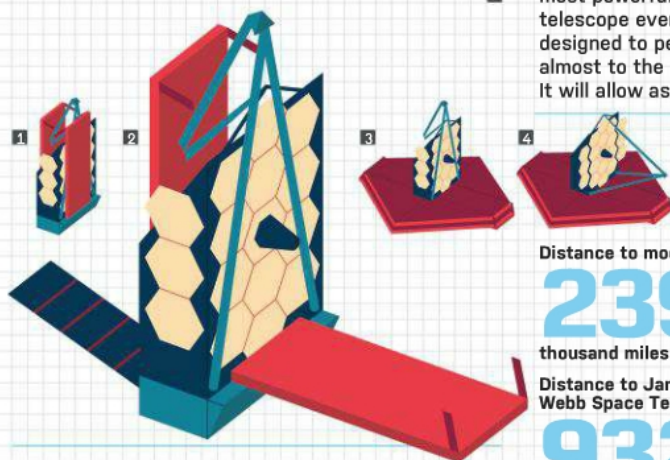
When completed at the end of 2013, at a cost of roughly \$4 billion, the 104-story building will have office space on 71 floors, a grand public lobby with 50-foot ceilings, and an observation deck more than 1265 feet off the ground. "Rebuilding on this site shows our unwillingness to just accept the attacks of Sept. 11," Foye says. "No one can bring those people back, but this tower will help make sure they're remembered."

New York City mayor Michael Bloomberg called the World Trade Center "probably the most complex construction site in any place, ever." Yet throughout 2012, the building has risen by approximately one floor per week.



PHOTOGRAPH BY KAI NEEDEN/REDUX

JAMES WEBB SPACE TELESCOPE



A massive shield will unfold to block the sun's rays and keep the telescope's instruments cold.

THANKS TO COLLABORATION from more than 17 countries, the James Webb Space Telescope (JWST) will be a formidable successor to the 22-year-old Hubble. The JWST will be the most powerful space telescope ever built, designed to peer back almost to the big bang. It will allow astronomers

to track the evolution of galaxies, observe star formation, and measure the chemical makeup of planets beyond the solar system. Looking back in time presents engineering challenges. With a 21.3-foot-diameter primary mirror—nearly three times that of Hubble's—and a polymer-film sunshield the size of a tennis court, the \$8.8 billion JWST will be packed into an Ariane 5 ECA rocket in 2018 and will unfurl in space en route to its orbit almost 1 million miles from Earth. "The solar array and high-gain antenna deploy first, then the mirror sections unfold, like leaves on a drop-leaf table," says Paul Geithner, Webb's deputy project manager. "This is as complicated a space deployment as NASA has ever done."

Distance to moon:

239

thousand miles

Distance to James Webb Space Telescope:

932

thousand miles

TOWERING RIVER SPAN

MISSISSIPPI RIVER BRIDGE PROJECT



THE POPLAR STREET Bridge connecting downtown St. Louis to southwestern Illinois has done yeoman's work since 1967, acting as a conduit across the Mississippi River for three interstates (I-55, I-64, and I-70)—one of only two bridges in the country to carry that many major highways. Drivers face 90 minutes of rush-hour traffic daily. Now, the Mississippi River Bridge project aims to alleviate the congestion.

The crown jewel of the plan, which includes some 38 different construction projects to reroute I-70, is a unique 2800-foot-long cable-stayed bridge upriver of the PSB. The span features two 400-foot-tall A-shaped towers (left) through which 1000 miles of 0.6-inch cable will run to support four lanes. The driving surface will consist of a steel framework supporting 450 concrete panels. When completed in 2014, the 1500-foot-long main span will make it the third longest cable-stayed bridge in the U.S.

THE CHEMISTRY OF CONCRETE

All concrete is made from the same three ingredients: water, aggregate, and portland cement—but it's not all created equal. Every structure requires a custom mix to balance the needs of workability, cost, and strength. Getting the recipe right is key.



The mix at 1 WTC is 60% aggregate, 31% cement, and 9% water (plus a heckuva lotta rebar). It's rated to 14,000 psi.



The new St. Louis I-70 bridge uses a mix that's 78% aggregate, 16% cement, and 6% water. It's rated to 6000 psi.

■ water ■ cement ■ aggregate

SHEPHERDS FLAT WIND FARM

THE SOLAR INDUSTRY may be faltering, but wind power continues to see double-digit growth in the U.S. Oregon expects to add 640 megawatts of capacity in 2012—all of it in one development spread across 30 square miles just south of the Columbia River. When the Caithness Shepherds Flat Wind Farm is complete in 2013, the 845 Mw produced will make it the largest onshore wind farm in the world. That's as much energy as is generated by 3.5 typical coal-fired power plants.

Producing the juice at Shepherds Flat are 338 GE Energy 2.5-100 turbines with rotor diameters larger than a football field. "These blades weigh 10 tons apiece," says Rich Reno, the head of GE's renewable wind efforts. According to GE's engineers, the drivetrain torque for each 80-ton turbine is equivalent to that generated by 5000 Ford F-150s.

But the massive undertaking hasn't been without controversy. Thanks to the Recovery Act, federal, state, and local subsidies will total about 65 percent of its \$1.9 billion cost, angering critics—but it has a number of high-profile backers. Google recently announced it was investing \$100 million in the project.

LADY LIBERTY VS WIND-TURBINE BLADE



GE's windmills are powerful giants. Each blade measures

160 feet

—taller than the Statue of Liberty.



GERALD R. FORD AIRCRAFT CARRIER

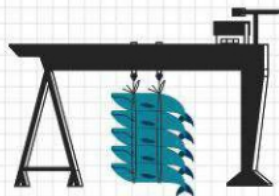
FOR THE FIRST TIME in nearly half a century, the world's most powerful warship is getting an upgrade. In 2015, the Gerald R. Ford class of nuclear-powered aircraft carriers will take over for the Nimitz-class supercarriers that have anchored America's Naval arsenal since the Vietnam era. While similar in appearance to the Nimitz class, the 100,000-ton-displacement Ford carriers will incorporate new technologies such as an Electromagnetic Aircraft Launch System, advanced arresting cables for slowing jets on landing, modern radar and combat electronics, and a nuclear power plant that will provide 2.5 times the electricity generated by its predecessor. Design and

construction efforts have benefited from a half-century of innovation as well. Engineers created a 3D model of the entire carrier, allowing for virtual walk-throughs so precise that technicians in 3D glasses can practice running cables and installing vents the way they soon will on the real ship.

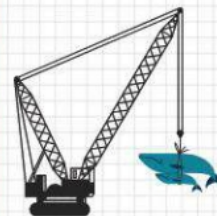
Construction of CVN-78, the first carrier of the line, began in 2005. The first Ford is estimated to cost \$9 billion, plus an additional \$5 billion for research and development (a price tag that has been rising of late to the irritation of many in Congress). A total of three carriers have been authorized for construction; CVN-78 is expected to be finished in 2015.

CRANE VS CRANE

LIFT CAPACITY:



Big Blue
5 BLUE WHALES



Manitowoc 7000
1.75 BLUE WHALES

Building big structures calls for big cranes. To lift rebar cages over 100,000 pounds for the I-70 bridge, the Missouri Department of Transportation barged in a 350-ton-capacity Manitowoc 7000. The hemisphere's largest gantry crane, the 1050-ton-capacity "Big Blue" is currently lifting sections of the PCU Gerald R. Ford.

RS-68A ROCKET ENGINE



THE WORLD'S MOST powerful hydrogen-fueled liquid rocket engines took their maiden voyage in June, successfully launching a government satellite. When the Pratt & Whitney Rocketdyne

RS-68A is mated to a Delta IV launch vehicle in a triple-engine configuration, the combo generates more than 2 million pounds of thrust, enough to lift 50,000 pounds into low Earth orbit. Hydrogen fuel requires more hardware but also delivers more thrust for the buck when putting big stuff into space.

SPACEPORT AMERICA

IN THE CHIHUAHUA Desert in New Mexico, the world's first private spaceport is nearing completion at a site so remote, builders had to pave a dozen miles of road just to get there, then build their own utilities once they arrived. Virgin Galactic's 110,000-square-foot Gateway to Space terminal and hangar facility is as high-performance as the spacecraft it will house. Elements such as a catacomb of 46-inch-diameter buried "earth tubes" to precondition the air and water-heating solar thermal panels on the roof will trim HVAC costs by 50 to 70 percent. That flowing roofline follows the contours of the desert and is made of hundreds of curved, individually cut sections with as little as 3 millimeters' wiggle between them.

Richard Branson's \$209 million playground is scheduled for completion in 2013, but the Spaceport's first 2-mile-long, 42-inch-thick "spaceway" has already held a successful flyover and landing by one of Virgin Galactic's huge WhiteKnightTwo mother ships during a dedication ceremony in 2011. The company is already selling tickets for upcoming flights on SpaceShipTwo for \$200,000.

FORD-CLASS CARRIER FIGHTER-JET CAPACITY



x75
F-35C Lightning II

SPACEPORT AMERICA AIRCRAFT CAPACITY



x5
SpaceShipTwo



x2
WhiteKnightTwo

BUOYANT HIGHWAY

SEATTLE FLOATING BRIDGE

SEATTLE'S FOUR- lane SR 520 bridge skims east to west across Lake Washington, connecting the Emerald City to Medina. But the overcrowded span carries more than 115,000 vehicles daily—almost twice what it was designed for—and after nearly a half-century, the 1.5-mile-

long floating bridge is showing its age. (The Inauguration Day storm of January 1993, for instance, necessitated repairs to 30,000 linear feet of cracks.) Replacing it with a suspension span was ruled out because SR 520 is a curved corridor—and with the lake's deepest point registering 214

The massive concrete pontoons for Seattle's six-lane floating bridge are being constructed in Aberdeen, Wash., and will then be towed to Lake Washington for assembly.



feet, support towers there would have to be nearly the height of the Space Needle. So engineers designed a new floating bridge that will sit just north of the existing structure—but with technology that is miles apart.

The new \$4.65 billion crossing, scheduled

to open in late 2014, will be built upon 77 hollow concrete pontoons—each measuring 28 feet tall, 75 feet wide, and 360 feet long—connected end to end, then anchored to the lakebed with steel cables to prevent swaying.

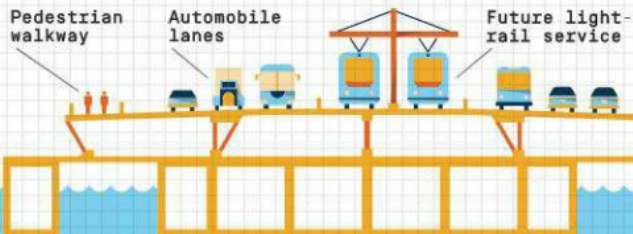
Twenty feet above the water—nearly 50

percent higher than the existing span—the 116-foot-wide roadway will support six lanes and have a 14-foot-wide bicycle and pedestrian path, plus there's an option to expand for future light rail.

Just as important, there are fewer moving parts: The current

SR 520 bridge has a drawspan in the middle to allow the passage of Seattle's bustling maritime traffic and to relieve wind and wave pressure on the bridge. The new design won't require a drawspan and will be able to withstand winds of nearly 90 mph.

HOW TO MAKE CONCRETE FLOAT



Floating a concrete bridge is easy, as long as you displace enough water—roughly 11,000 tons per hollow pontoon. But you have to make sure the pontoons don't leak. Engineers added microsilica and fly ash to the concrete mixture to keep everything watertight.

LARGE CORPORATE DOUGHNUT

APPLE CAMPUS 2

APPLE IS FAMOUS FOR REGULARLY unveiling shiny new gadgets to the masses, but one of its slickest future designs is for employees only. Currently under review by the Cupertino, Calif., city council is Apple's planned 175-acre Campus 2, which, upon its planned completion in 2015, should accommodate as many as 13,000 employees. "It's a little like a spaceship landed," former CEO Steve Jobs told the council in June 2011. "There's not a straight piece of glass in this building. It's all curved." The campus will have a fitness center, an underground 1000-seat auditorium, and a 300,000-square-foot research facility—all connected to the main offices via a web of subterranean channels. Aboveground, the plans call for more than 6000 trees of more than three dozen varieties and a rooftop solar array that will be one of the largest corporate installations in the world.



"IN TERMS OF SIZE, IT IS IMPERATIVE THAT EVERYTHING WE DESIGN WORKS AT A HUMAN SCALE, HOWEVER MONUMENTAL THE PROJECT."

— SIR NORMAN FOSTER, architect of both Spaceport America and Apple Campus 2

MASSIVE WATER MOVERS

OLMSTED LOCKS AND DAM

JUST BELOW PADUCAH, Ky., at the confluence of the Mississippi, Ohio, Tennessee, and Cumberland rivers, the busiest inland waterway in the U.S. hits its gnarliest bottleneck. There, nearly 15 percent of all domestic modern river cargo—90 million tons last

year—is forced to sit for up to 24 hours before passing through a lock and dam system from a bygone era. Now a construction project of modern locks and dams is transforming the waterway. There has been progress (two 110-foot-wide by 1200-foot-long lock

chambers were completed in 2002) and setbacks (cost overruns and delays have pushed the projected completion date of the \$2.9 billion dam to 2024). But planners estimate the project, when completed, will pay for itself in five years. **PopMech**

8–10 feet
vertical distance between upper and lower pools

1.3 million gallons
water moved during lockage operation

22,500 tons
cargo moved per lockage

6 8

SEPTEMBER 2012 • POPULARMECHANICS.COM

Backyard Genius

2012

In honor of the magnificent creative spirit that inhabits our land, we present you with our annual list of the most useful, outrageous, ambitious, and, yes, electrifying amateur engineering projects in America.

By **Davin Coburn**

Photograph by Kyle Johnson



Nerf Tesla

Rob Flickenger, Seattle. Age: 37 This self-proclaimed mad scientist turned a Nerf gun into the ultimate sci-fi sidekick. "Not long ago, I picked up [the graphic novel] *The Five Fists of Science*, all about Nikola Tesla and Mark Twain battling the evil Thomas Edison," Flickenger says. "Tesla carries these steampunk guns that fire lightning bolts—I had to have one." Not even the sky-high voltage generated by a spark-gap tesla coil could deter him. A tech writer by day, Flickenger designed the porcelain-and-tungsten switch at the heart of the system on a 3D printer. The output is tied to a flyback transformer from an old TV, and six Cornell Dubilier capacitors sit in a laser-cut housing atop the weapon. The device is powered by an 18-volt lithium-ion battery. When paired with the circuit nestled inside a PVC end cap, those 18 volts turn into nearly 200,000. "That capacitor bank could kill you twice before you hit the ground," Flickenger says. In other words, try not to play with it in the house.



The Seattle author found a way to squeeze 200,000 volts of electricity from a Nerf gun cast in aluminum.

Using store-bought parts and a glass tube from a neon sign, Jessie Tank built a CO₂ laser in her dining room.

Compact Go-Karts



With 4-inch tires and an aluminum frame, Charles Guan's miniature go-kart weighs all of 36 pounds.

Charles Guan, Cambridge, Mass. Age: 23 Think of it as bringing horsepower to the people. On a whim last spring, the MIT masters student built a mini go-kart—or Chibikart—with custom-machined hub motors and a massive 33-volt lithium-ion battery. Amateur builders cheered the accomplishment online—and then furrowed their collective brow. "People were dismissing it as a privileged college kid project," Guan says. "So I decided to make a democratized version." Powered by a pair of standard 12-volt lithium iron phosphate batteries, the two-wheel-drive Chibikart 2 roams the school hallways on 4-inch rubber tires. The twin 1-hp drive motors were designed for RC model aircraft. "They're some of the best power-to-weight-ratio parts available for any kind of propulsion," Guan says. The 36-pound chariot stops thanks to brakes fashioned mostly from stock bicycle parts. Top speed? About 22 mph, which means Guan may want to think about buying himself a helmet.



Laser to Go

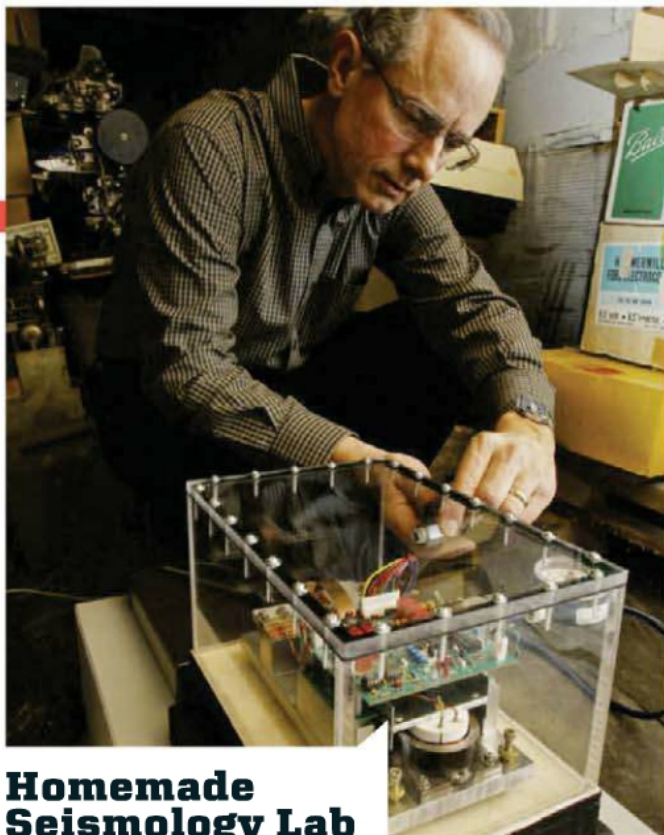
Jessie Tank, Anchorage, Alaska. Age: 34 Not long ago,

Jessie Tank, who manages a computer store, found herself reflecting on the CO₂ laser she had cobbled together with her father in high school. Before she knew it, she was re-creating the experience in her dining room. Her new laser uses a mixture of CO₂, nitrogen, and helium sealed in a 13-mm glass tube from a neon-sign store. The gases are excited by electricity from a 400-watt variable transformer connected to an amp meter and mounted in a plastic toolbox. When the gas molecules collide, they release a beam of infrared light that bounces off two gold-and-zinc mirrors before zipping off in search of something to set on fire. "It's not strong enough to cut steel," Tank says of the beam, "but it's certainly enough to burn wood or paper. Or ignite gun powder—though I try to be considerate of the neighbors."

PHOTOGRAPHS BY GUIDO VITTI (GO-KART), KYLE JOHNSON (LASER)



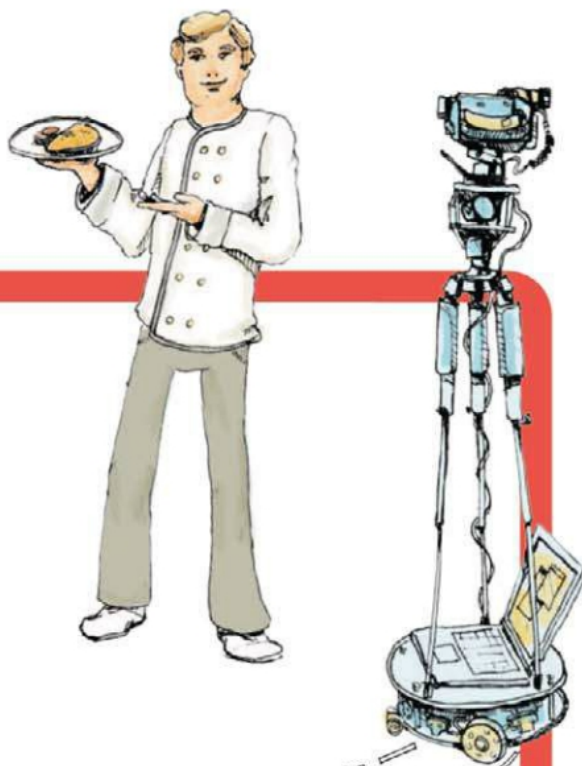
If the earth moves under his feet (even by so much as a hair), Steve Jones knows about it, thanks to his basement seismometer.



Homemade Seismology Lab

Steve Jones, Huntsville, Ala. Age: 58 On Alabama's earthquake-tracking Web page, you'll find data from the state's official monitoring stations. Only one—the AlabamaQuake amateur seismic station—reports on the tremors from Steve Jones's basement. Ten years ago, the NASA engineer built his first seismometer: a Shackleford-Gundersen horizontal model. It was a fine place to start but nothing compared with his Inyo Force Balance Broadband Vertical seismometer. Machined from aluminum and brass, the device sits in a hermetically sealed pressure case with a thermal cover because the pendulum is so sensitive, the heat from a flashlight beam will set it off. "I can tell when the ground here moved 3 millimeters," Jones says. "We don't feel it, but it's fascinating to know when Huntsville shifts because of a quake in Japan."

PHOTOGRAPH BY GLENN BAESKE (SEISMOLOGIST)



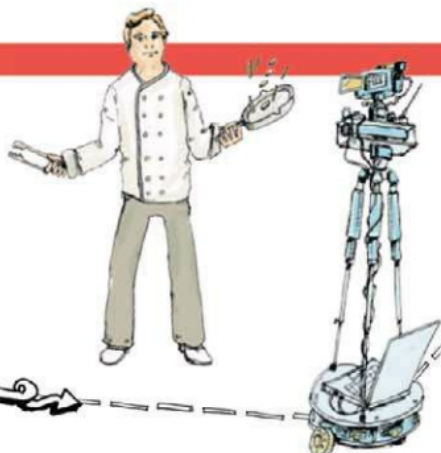
Robo Tripod

Arthur Wait, Menlo Park, Calif. Age: 45

Let's face it: It's hard to broadcast yourself on YouTube when you're a one-man band. Who's going to hold the camera? Well, why not let Arthur Wait answer that for you. "YouTube has become more TV for me than TV is," says the software developer, who won the grand prize in Microsoft's Robotics @ Home Challenge. "There's a ton of great stuff there. It's a shame it's not always shot very well." With that in mind, the amateur photographer took a Parallax Eddie robot, a Kinect sensor, and Microsoft's Robotics Developer Studio and invented a roving tripod—one that rolls right alongside you, tilting and panning in response

to certain hand gestures. This makes filming slightly more adventurous, of course. (Wait's walls have the nicks to prove it.) "But," he says, "once you understand what you're doing, you become a director." Even better, in that acceptance speech on Oscar night, you have no one but yourself to thank.

Thanks to Arthur Wait's roving tripod, hackers and DIY aficionados can now document their projects on YouTube without having to hire a camera crew.



Inspired by a 1968 late-night look at the Golden Gate Bridge, Larry Richardson decided to build this replica in Kansas.



Golden Gate II

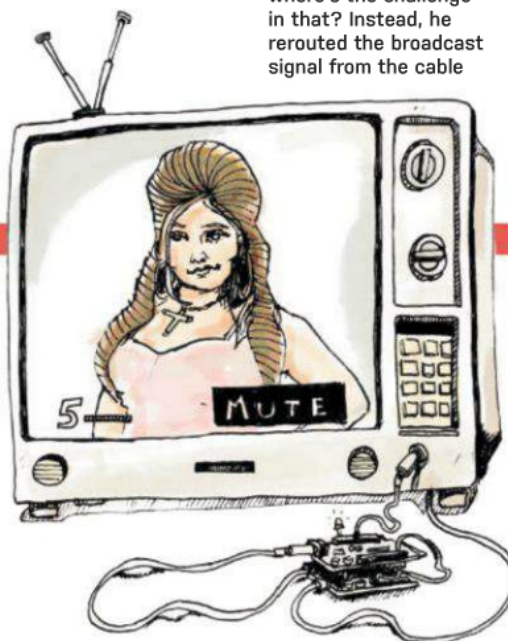
Larry Richardson, Mulvane, Kan. Age: 64 On his way to Vietnam in 1968, Larry Richardson caught a glimpse of the Golden Gate Bridge. Before shipping off, he picked up a postcard at the Army commissary. A year later, he returned home to Kansas. His wife, Barbara, put the postcard in a scrapbook, where it sat for 25 years—until the couple bought property with a creek. Using the postcard as a reference, Richardson took posts salvaged from a bridge, and cables from a plane and an oil rig and set to work with his aging father. "He and I had never been close," he says. "This let us bond." The 150-foot replica took seven years, \$4000, and 97.5 tons of concrete to complete. In June, the retired postman boarded a plane for the first time since Vietnam. He returned to the Bay Area to show his wife his favorite landmark.

The Snooki Silencer

Matt Richardson, Brooklyn, N.Y.

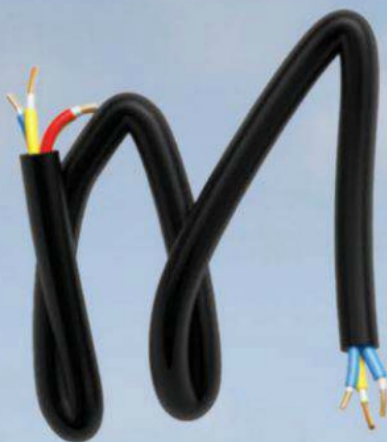
Age: 30 Blame it on Kim Kardashian. As TV coverage of the reality star's impending nuptials reached a fever pitch, Matt Richardson, a grad student in NYU's Interactive Telecommunications Program, decided to do something about it. He could have simply turned off the TV, of course, but where's the challenge in that? Instead, he rerouted the broadcast signal from the cable

box into his Enough Already device, where a code he wrote scanned the closed captioning for offending language. (For Richardson, it was "Kardashian"—though "Red Sox," "election," and "Miami cannibal" work just as well.) When the system spots the trigger term, an Arduino board activates an LED. The bulb flashes the signal for "mute" and—voilà—you get celebubante-free air-time for 30 seconds. "You could also flip it around," Richardson says, "to turn the TV on if there's something you do want to hear about."



What does it take to mute a reality-TV star? Little more than an Arduino and some code, says Matt Richardson.

No-Roads DeLorean



Matt Riese, San Francisco. Age: 28 If you're going to take the time to build your own hovercraft, why not make it unique? After four years of effort, Matt Riese—a man of many odd jobs—is putting the finishing touches on this *Back to the Future*-inspired ride, fulfilling a DeLorean dream that began in middle school. "I'd done home remodeling but never a project like this," says the jack-of-all-trades. "When I stood back and looked at the first version, I realized I'd just kind of powered through it. So I decided to rebuild one part, then another. By the end I'd rebuilt almost everything." Based on Universal Hovercraft's UH-13PT Twin Trainer, Riese's silver star is sculpted from foam insulation covered in fiberglass. The doors and frame are reinforced with wood and aluminum. A lift motor inflates the air cushion, and a 16-hp horizontal-shaft engine at the rear stands in for "Doc" Brown's flux capacitor. The thing can easily ferry two people across flat land, but Riese didn't stop there: He made his DeLorean seaworthy too. Registered with the California DMV as a boat (it's not street-legal), the craft can travel close to 45 mph. That doesn't compete with Marty McFly's 88 mph—but it's plenty fast for a vehicle with no brakes.

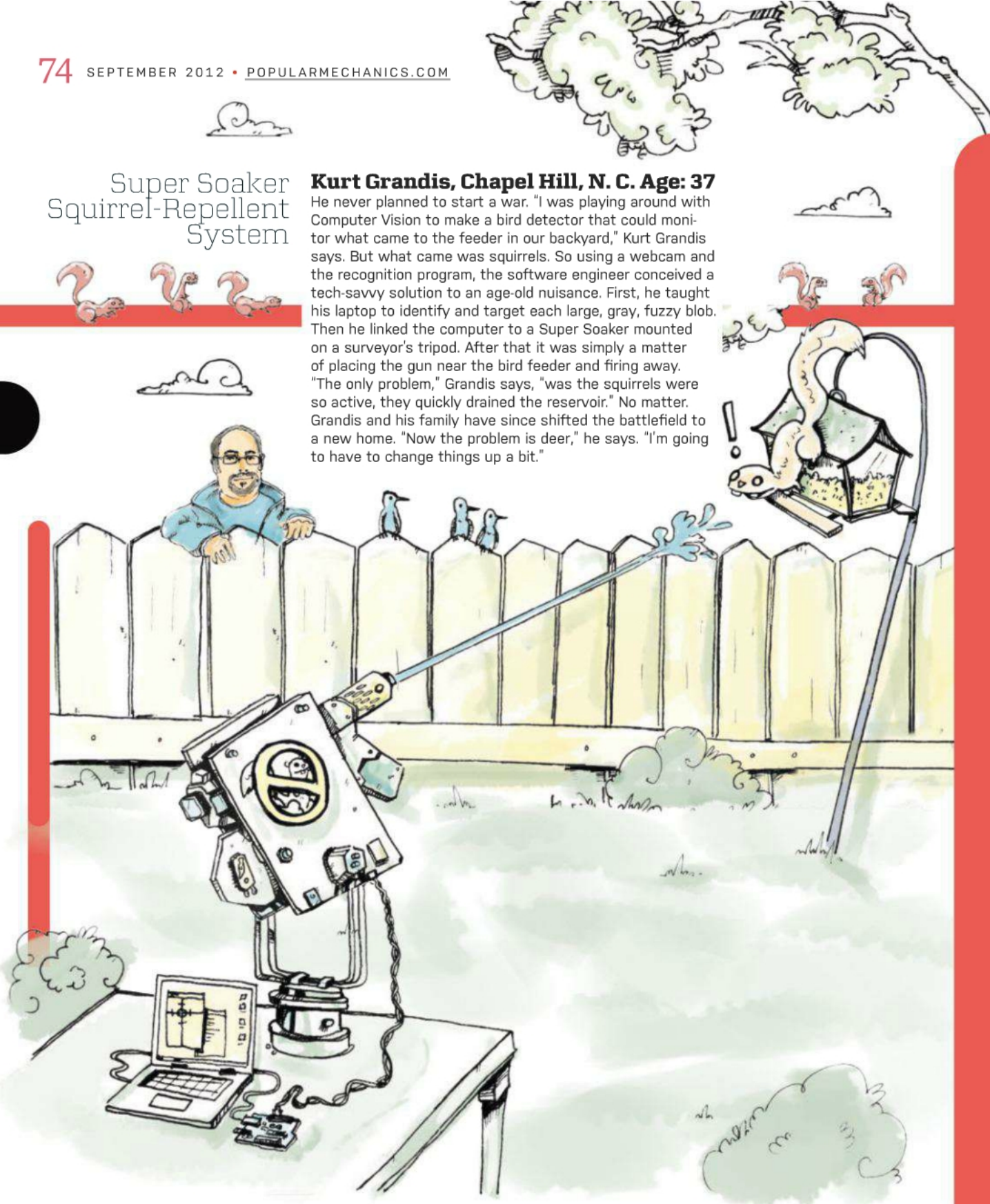
After making a few modifications to a hovercraft kit, Matt Riese was driving a DeLorean in San Francisco Bay.



Super Soaker Squirrel-Repellent System

Kurt Grandis, Chapel Hill, N. C. Age: 37

He never planned to start a war. "I was playing around with Computer Vision to make a bird detector that could monitor what came to the feeder in our backyard," Kurt Grandis says. But what came was squirrels. So using a webcam and the recognition program, the software engineer conceived a tech-savvy solution to an age-old nuisance. First, he taught his laptop to identify and target each large, gray, fuzzy blob. Then he linked the computer to a Super Soaker mounted on a surveyor's tripod. After that it was simply a matter of placing the gun near the bird feeder and firing away. "The only problem," Grandis says, "was the squirrels were so active, they quickly drained the reservoir." No matter. Grandis and his family have since shifted the battlefield to a new home. "Now the problem is deer," he says. "I'm going to have to change things up a bit."



Armed with a Super Soaker and Computer Vision recognition software, Kurt Grandis launched a surprise attack on the squirrels that were invading his backyard bird feeder.

Galactic Flight Trainer

John Boyer, Joseph DeRose, Sam DeRose, Sam Frank, Alex Jacobson; San Rafael, Calif. Ages: 8th grade to high school senior Don't be deceived by those boyish smiles. These guys may look like plebes, but they're veteran hackers. Just ask the folks at Maker Faire. "We spent eight months on this project," Sam DeRose says. "But it was only recently that

we looked back and said, 'Oh my God, that really worked.'" Built inside a Piper Cherokee fuselage scavenged for \$400, the DIY flight simulator is modeled on the Colonial Viper aircraft from *Battlestar Galactica*. It has three screens that run the open-source FlightGear program. The Bay Area students wired

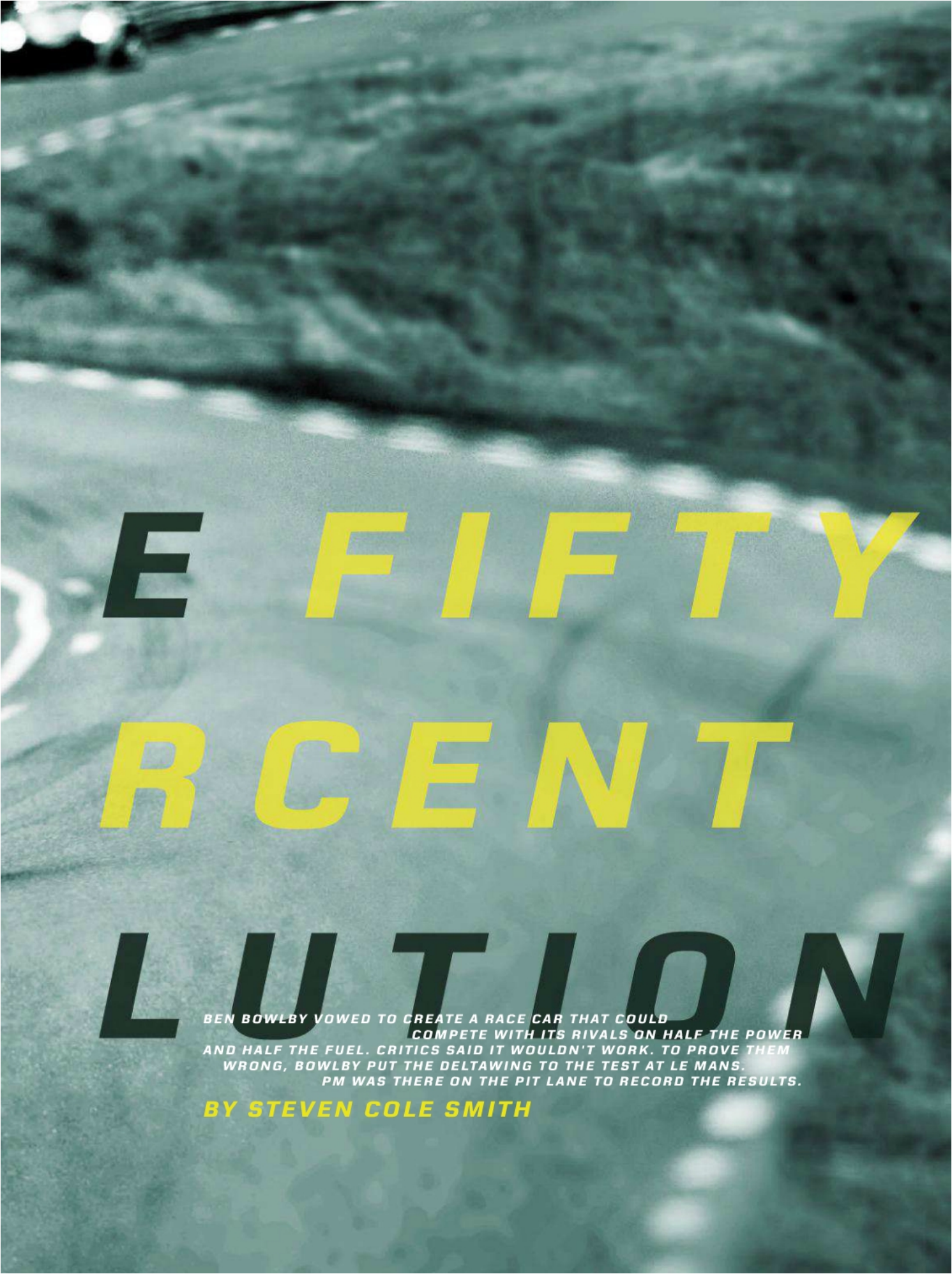
the joystick-controlled software into 1-hp motors on the platform, allowing for 360-degree motion on the pitch and the roll axes. The five teens paid for the R&D with a Kickstarter campaign. "We play video games and that kind of stuff," says Sam, who will soon begin his studies at Harvey Mudd College. "But for me, being out in the garage building things is just something I have to do." **PopMech**

Sam Frank, John Boyer, and Alex Jacobson (from left) teamed with two pals to build a flight simulator inspired by *Battlestar Galactica*. Controlled by a joystick, the sim features 360-degree motion on two axes.





Lean Machine:
The DeltaWing
qualified for
Le Mans at a
top speed of
192 mph.



E FIFTY RCENT LUTION

BEN BOWLBY VOWED TO CREATE A RACE CAR THAT COULD
COMPETE WITH ITS RIVALS ON HALF THE POWER
AND HALF THE FUEL. CRITICS SAID IT WOULDN'T WORK. TO PROVE THEM
WRONG, BOWLBY PUT THE DELTAWING TO THE TEST AT LE MANS.
PM WAS THERE ON THE PIT LANE TO RECORD THE RESULTS.

BY STEVEN COLE SMITH

IN THE 80 YEARS OF RACING AT LE MANS, THE TRACK STEWARDS HAD NEVER SEEN ANYTHING LIKE IT. As the sleek black auto eased its way onto the grid, they could not help but marvel at the long thin nose and the bulging, Batmobile-like tail. Even among the various classes of cars—the winged

prototypes, the Porsches, the Ferraris—that surrounded it, waiting for the race to begin, the DeltaWing stood out like a beacon. Its custom-made front tires each measured only 4 inches wide. They sat less than 2 feet apart, making the craft look like a jet-propelled tricycle. For months, it had been hailed as the future of motorsports, the most efficient race car on the planet, but many questioned whether the thing could even turn.

A half-mad experiment orchestrated by the engineer Ben Bowlby, the car had barely been tested. Bowlby's one-time boss, Chip Ganassi, who owns IndyCar, Nascar, and Grand-Am teams, summed up the project in what would become the DeltaWing mantra. "Here are the key points," he said. "Half the cost of the current car, half the weight, half the drag, half the downforce, half the fuel—same speed."

For his part, Bowlby wanted to turn heads, too. Dismayed by the lack of innovation in racing, he longed to give his three children a reason to click on the TV and wonder at the technical prowess in the sport he loved. Without question, his dream machine looked fierce. If you peeked under the carbon-fiber body, though, you couldn't help but see how delicate the DeltaWing team's hopes were. The rear axles were not much bigger around than those on a riding mower. The front suspension had been assembled using springs the size of a Red Bull can. They resembled something you'd find on a mountain bike. To get the DeltaWing down to fighting weight—under 1200 pounds with driver and fuel—the crew had to sacrifice some heft. Bowlby himself had said it would be a "mighty miracle" if the car finished the 24-hour race. His backers hoped it would run long enough to prove its point.

Now nearly 600 million people were watching worldwide to see how it did on the track.

BEN BOWLBY HAS BEEN DESIGNING race cars for 25 years, first for the international manufacturer Lola Cars, then as Ganassi's technical director. Like most engineers, he'd thought a lot about how to do things better. And like his motorsports peers, he always found himself stifled by racing's rule books. "I realized that I was



Rebel With a Cause: After following the rule book for 25 years, Ben Bowlby wanted to shake up the business. His DeltaWing concept is a radical rethinking of race car design.



The Little Engine: The 300-hp 1.6-liter four-cylinder is so lightweight that one man can cradle it in his arms.

part of a dinosaur industry," he said.

In 2008, at Ganassi's urging, the bushy-browed Brit began sketching out a revolutionary vision, a lightweight rocket powered by a modest engine. He knew that the world's automakers were pushing for efficiency. With fluctuating gas prices, rising costs, and mounting cries for environmental awareness, they were clamoring for sensible solutions. By contrast, motorsports was inching down the road toward eco-conscious racing. Bowlby dared to give it a great big shove.

To test his idea, he built a small radio-controlled model. To his delight, it worked. With backing from Ganassi, he created a full-size model in Indianapolis in 2010. The IndyCar series was planning to unveil a new chassis for the 2012 season, and the two men threw themselves headlong into the competition. Ultimately, the concept was just too radical. The racing world had not taken such a great leap forward since the late 1970s when Lotus's winged ground-effect cars stormed the Formula One circuit. IndyCar opted to stick with the Italian manufacturer Dallara Automobili. Bowlby was crushed.

His hopes for a thumbs-up had vanished—or so he thought. Three months later, he pitched the idea to the French board that oversees the 24 Hours of Le Mans. Intrigued by the notion of a fuel-efficient race car, the group offered him a berth in its newly christened Garage 56, a showcase for experimental cars. The DeltaWing would not compete, but it would get to run with the 55-car field.

Bowlby had one year to streamline the design, build the car, and test it. To succeed, he'd have to shave nearly 1000 pounds from the typical Le Mans prototype. That meant rethinking everything, from the tires to the transmission to the brake and exhaust systems.

With little prospect for a series-wide licensing deal, Ganassi was ready to move on, so Bowlby talked his way into the All American Racers shop, founded by Dan Gurney. Besides being one of America's best car builders and a legendary driver, Gurney, now 81, is regarded as a novel thinker, the first man to wear a full-faced helmet in Formula One, the guy who started the tradition of spraying champagne on the winner's podium. "I don't know when a car tickled my innards the way this one does," Gurney said. "I can't remember an innovation that has the visual impact that the DeltaWing does, and the technology makes so much sense."

The DeltaWing's first on-track test, at Buttonwillow Raceway Park, a dusty little road course in the California desert northwest of

Bakersfield, was scheduled for the first week of March. The car needed an engine. Bowlby and team pitched many manufacturers; only Nissan of Europe bit. The company agreed to supply the 1.6-liter turbocharged four-cylinder engines on one condition: The DeltaWing had to prove itself on the track. A handful of reporters were present when the car took its first tentative laps, then broke down. It took a few more, then broke down again. Despite some wiring glitches and minor brake and transmission issues, the car cobbled together enough laps to demonstrate that, yes, it was fast, and, yes, even with those tiny front tires, it could handle racing turns.

Day after day, the thrash continued. The crew of about a dozen worked tirelessly in the small concrete garage. Each problem was met and resolved in a climate that resembled that of a high-tech startup or the early days of the space program—people toiling, sometimes without pay, on a project that *might* make history. They'd work until dark, set up lights, and work some more until 1 am, when they'd all head to the Motel 6 and sleep until dawn.

Nissan dispatched its own drivers and engineers to put the car through its paces. To protect the company's interests, they arrived in plain clothes. The DeltaWing passed the test.

DeltaWing's Pilots: Marino Franchitti (younger brother of IndyCar champion Dario), Michael Krumm, and Satoshi Motoyama shared the driving duties at Le Mans.



BETTER BY HALF

With these five goals in mind, the DeltaWing team set out to create the world's most efficient race car. Did they succeed? Yes—with a few concessions.

HALF THE DRAG

Once you exceed 60 mph, aerodynamic drag plays the biggest role in limiting a car's speed. The DeltaWing's slippery profile has a drag coefficient of 0.24 versus the 0.47 of the vaunted Audi R18s.



HALF THE MASS

At 1047 pounds, the car is roughly 900 pounds lighter than its Le Mans peers. Thanks to the sleek nose, 72.5 percent of the weight is positioned over the rear wheels, making the car surprisingly nimble.



HALF THE POWER

With less drag and less weight, the DeltaWing's 300-hp engine provides enough get-up to compete at Le Mans' LMP2 pace. The car qualified for the race at a speed of 192 mph.



HALF THE FUEL

The DeltaWing took to the track with a 40-liter fuel tank, hoping to squeeze 12 laps out of each pit stop. The diesel-powered Audis were hoping for 13 laps on 63 liters.



HALF THE TIRES

An Audi R18 claimed victory and bragging rights in 2011 using nine sets of treads. With one tire change in 6 hours of racing, the DeltaWing was poised to crush that mark.



On March 13, Nissan announced that it would power the car. Due to the tight deadline, however, the company contracted with a British race shop to custom-build an engine based on Nissan's design. In the end, the only genuine Nissan part included was the throttle-body assembly.

WHEN THE DELTAWING ROLLED onto the Le Mans track on June 16, Michael Krumm of Highcroft Racing was sitting behind the wheel. Organizers had advised the team to have fun during the 24-hour endurance test—so long as the car didn't interfere with the racing. Among the field were two classes of fleet prototype cars and two classes of GT cars such as the Porsche 911 and the Ferrari 458. Bowlby had predicted that the DeltaWing would qualify at speeds comparable to some prototypes, and it did. Krumm—who would share the driving duties with Marino Franchitti and Satoshi Motoyama—admitted he could have gone faster. His top speed was measured at just over 192 mph.

The fans at Le Mans cheered when the DeltaWing took to the grid. At 3 pm the race got underway. Thirty minutes in, Bowlby's team encountered its first challenge. A piece of plastic flew into the opening for the radiator, and the engine began to overheat. Next it was brake trouble and then issues with the shifter—both a result, Bowlby said, of faulty off-the-shelf parts.

In the end, it wasn't technology that did in the car but human error. Several hours into the race, Motoyama took the wheel. Soon after, a Ferrari 458 Italia clipped the side of a hybrid Toyota TS030. In a chilling reminder of what happens when you push a car to speeds of 200 mph, the Toyota went airborne, sailing into a steel barrier behind a wall of cast-off tires. It took more than an hour to remove the battered cars and attend to the Toyota driver, who had fractured two vertebrae. In the meantime, Motoyama circulated behind the pace car with the rest of the field.

Just after the 6-hour mark, racing resumed. On the first lap, Motoyama did what he'd been instructed to do, pulling to the far right of the track, well clear of the hard-charging cars behind him. Kazuki Nakajima, rookie driver of the remaining Toyota hybrid, was not nearly as careful. In a split-second lapse of judgment, he drifted into the DeltaWing's side, sending Motoyama into a concrete wall.

For a moment, a stunned silence swept the DeltaWing garage. A flurry of activity followed. Race rules permit the driver, and only the driver, to work on the car. While safety crews pulled the DeltaWing behind a barrier, members of the crew rushed to the crash site with tools in hand. For more than 90 minutes, Motoyama toiled on the vehicle, dashing to the fence for advice. The

front steering was broken, as well as one of the rear drive axles. As darkness fell, reality descended on the team. The DeltaWing's day was done.

Motoyama walked through the gate into the crowd. Beneath his Arai helmet, he cried.

The car was loaded onto a rollback wrecker and taken to the impound lot. A crane lowered it into a parking space. The wrecker crew finished up and drove away, leaving the car and three big pieces of carbon fiber in a dark corner of the fenced lot.

In the hours after the crash, Bowlby shared his thoughts with a member of the Highcroft team. The car had achieved its goals, he said. It kept pace with the prototypes using basically half the fuel and half the tires. "Let's hope we can bring it back as a race car," he added, "not just an experimental vehicle."

Don Panoz, the mercurial chain-smoking millionaire who helped bankroll the project, is eager to make that happen. Next month the car will appear in the Petit Le Mans race in Atlanta, he says. And he plans to race DeltaWings next year in his American Le Mans series. The question mark is Bowlby, who did not have a single day off in the 12 months before Le Mans. He has no financial stake in the project. Indeed, as the pressure to deliver intensified, the engineer seemed to sag under the weight of the expectations. As he hugged his crew and said farewell in the garage, he looked inches taller, as if a great burden had lifted.

Doug Fehan, head of the Chevrolet Corvette racing program, fielded two cars powered by massive 5.5-liter 500-hp V-8 engines at Le Mans. An hour after the DeltaWing crash, he sat in the pits and offered an epitaph.

"Ben Bowlby is one of the bravest men I know," he said. "He gave up everything to follow this dream. In the end, he knew one of two things would happen. People would walk up to him and say [in a mocking tone], 'So, you designed the DeltaWing.' And his career would be over.

"Or they'd say [with reverence], 'So, you designed the DeltaWing.' And he'd be a hero."

Fehan smiled. "He's a hero." **PopMech**



Broken Dreams: After working valiantly to get the car running, Satoshi Motoyama left the track in tears.



STAND UP TUNE IN

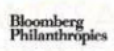
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STEPPING *Stones* TO A BETTER BED-STUY

Popular Mechanics, along with Rebuilding Together New York, traveled to Brooklyn's historic Bedford-Stuyvesant neighborhood to provide assistance to a community that has a remarkable story of helping itself and its residents.



BEDFORD-STUYVESANT, OR *Bed-Stuy* AS IT'S COMMONLY KNOWN, HAS EXISTED SINCE THE 19TH CENTURY.

As with most long-standing communities, it has seen its share of both prosperity and decline. Bed-Stuy experienced its most notable resurgence in the 1990s, when new residents and a revitalized spirit rejuvenated the area after two decades of crime and urban plight.

That spirit remains. In early June, volunteers renovated four buildings in Bed-Stuy, all located on Halsey Street—three residences and the Rose F. Kennedy Family Center. The Family Center has been a focal point in the neighborhood since its founding in 1989, when it received a \$1 million seed grant from the Joseph P. Kennedy, Jr. Foundation to help the homeless.

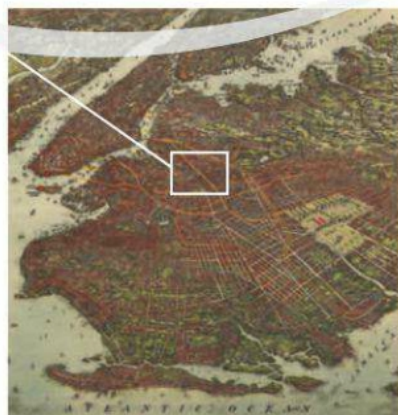
With the seed grant money and additional funds from the New York State Homeless Housing Assistance Program, the Family Center purchased a four-story brownstone and converted it into a transitional residence. Today the center offers housing, counseling and other social services for homeless, pregnant and parenting young women and their children.

“Our goal is to get the women who come to live here to become self-sufficient,” says Vanessa Boucher, program director of the Family Center. “It’s easy to think of a place like this as simply a ‘shelter,’ but when you walk in, you’ll notice that it doesn’t look like one. We give it a home-like atmosphere where, when the girls come in, they feel as if they’re somewhere they can actually become a little bit stable.”

And it’s true—it does have a relaxed atmosphere, very unlike a “shelter.” When you

BED-STUY

Bedford-Stuyvesant’s roots go back to the 19th century, though it was officially formed as a neighborhood in 1930. Thanks to the development of electronic trolleys and elevated trains, Bed-Stuy became a working-class community for those employed in Brooklyn and Manhattan. The development of brownstone homes and buildings has helped give Bed-Stuy a unique architectural presence that continues to this day.



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Lift
Workers from BuildingWorks apply DRYLOK Extreme to the foundation of the Family Center.

Bottom Left
Volunteers gather in the Brooklyn Adult Learning Center for debriefing before beginning work.



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enter the building, you understand why it's called a Family Center. The street level houses a daycare center, a kitchen, a reception desk and two offices. A food pantry is located in the basement. On the roof, you'll find a fenced-in play area for the children. The three floors in between hold 14 resident rooms.

Marlicker Sampson appreciates the Family Center's efforts to make the center feel like home. In her early twenties, Sampson has spent five months at the Family Center with her nearly two-year-old daughter and is now preparing to leave—and she's ready. "I've learned so much here," says Sampson. "I'm happy to be getting out on my own, but it's so much like a family here, and that's what I'll miss the most. We all look out for each other. Miss Vanessa and the people who work here take care of us, too, but mostly, they've taught us to take care of ourselves."

So, it's no surprise that when the Family Center required additional facility improvements not covered by the funding they received, they connected with Rebuilding Together New York. Linda Thorne, president of the Halsey Street Arlington Place Progressive Block Association and member of the Family Center's board of directors, tells the story.

"I had been working with Retrofit, another restoration organization, about a different project in our community," said Thorne, "and they were the ones who connected me to Matt Lang, the executive director of Rebuilding Together New York. That was about a year ago."

Lang stated, "We're always looking to strengthen our foothold in these communities, and Linda helped us do that." He added, "Our strategy is to get rooted in these communities, stay involved and get the word out. That way, you make a presence

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Right

New wood flooring is installed in the Family Center's main hallway.

Bottom Right

A BuildingWorks worker using FEIN tools to prepare the existing frame-work for flooring.



over a longer period of time and are able to do more projects with more volunteers."

Lang was also instrumental in securing an organization called BuildingWorks to help with the repair and rebuilding projects at the Family Center, truly exemplifying Bed-Stuy's official motto: "Unity Makes Strength." Started in 1995, BuildingWorks is a pre-apprenticeship skills training program in construction and building trades. Young men and women enter into an intensive 17-week training program divided between class time and hands-on, job-site work. Students learn a variety of building trades and get the opportunity to earn licenses and certifications that can enable them to go on to careers as carpenters, electricians, sheet metal workers and iron workers.

"The goal of the program is to get these kids union jobs in their specific fields," says Richard Saturno, a BuildingWorks instructor for 12 years. "We've been very successful. In fact, in our last class of students, 12 students applied to get into a union, and 11 passed the test and are now working in union jobs."

The crew from BuildingWorks primarily focused on the Family Center, doing much of the work on the ground level. The floors were first. Thanks to FEIN MultiMaster Start Q power tool sets, workers easily and expertly removed chipped linoleum tiles and powered through steel and cement to ensure the wood flooring fit seamlessly when installed—making the interior construction and renovation tasks easy.

BuildingWorks also renovated the kitchen, installing new cabinets, countertops and backsplash, as well as a new dishwasher and refrigerator. They also refurbished the cabinet, sink and faucet in the nursery. During this overhaul, the donated MadGrip® Gloves were not only durable and comfortable, they also helped to protect the workers' hands as they tackled the heavy construction, and they ensured a good hold when handling the large appliances.

Outside, the team cleaned the surface of the Center's cement foundation, patching all holes and cracks, and sealing the wall joints. Next, they applied DRYLOK® Extreme Masonry Waterproofing to help prevent water damage and control mold and mildew growth.

BuildingWorks completed their work on the Family Center during the week. On Saturday, June 9, volunteers from Deutsche Bank, King & Spalding LLP, Shawmut Design and Construction, Wilson Sonsini Goodrich & Rosati, and Lend Lease, along with Popular Mechanics and Rebuilding Together New York, came out to the area to wrap things up. Each volunteer was assigned to a team and then went to his or her respective site.



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Left
Volunteers also worked outside the Family Center, putting fresh plants into flower boxes.

Here
Volunteers apply KILZ Premium primer to an entrance door at the Family Center.

Work continued in the Family Center, where volunteers painted offices and hallways. All wall and door surfaces were coated with KILZ® Premium primer to ensure the aged paint and stains were thoroughly covered, and to enhance the new coats of paint. Before painting, volunteers made sure to line door frames, window frames and ceiling tops with FrogTape® with PaintBlock® Technology to ensure no bleed-through and sharp, precise paint lines. Flower box plantings and landscaping projects also brought a splash of color to the outside of the Center.

The three residential brownstones on Halsey Street also benefitted from the project; some renovations were small yet vital, and others required more extensive work. Shawmut Construction, a long-term Rebuilding Together New York project sponsor, significantly upgraded one home. Their team renovated the kitchen, foyers and a bathroom, and replaced the flooring and hung sheetrock in one of the bedrooms, all so that the homeowner could create a rental unit in her brownstone in order to keep the property.

The revitalization of the Bed-Stuy neighborhood is still in progress—the buildings, the businesses and the people. “You’ve got to come here with a level of compassion and understanding,” said Boucher. “This isn’t a job for me. It’s a calling. It’s a calling to serve and help build better, stronger women.”

“The Family Center has helped me so much,” adds Sampson. “They’ve helped me go in the right direction. But they’ve also taught me that you have to do some of the work. This is just a stepping stone to what I want to do in my life. I’m ready to move forward.”

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Vanessa Baucher

has been with the Rose F. Kennedy Family Center since 2007, not only serving as its program director, but also as a mentor to the young women in the center.

"These women need mentors. Yes, we give them a place to stay and teach them how to get back into the community, but what's important to me is giving them someone to talk to, someone who will listen and help. That's what this center is about."



Popular Mechanics was proud to be part of the Halsey Street Rebuilding Together Project in Bed-Stuy. To learn more about these organizations, or to donate or volunteer your time, feel free contact them directly:

Rebuilding Together New York:
www.rebuildingtogethernyc.org (212-362-1636)

Rose F. Kennedy Family Center: www.bcafs.org
(973-454-1363)

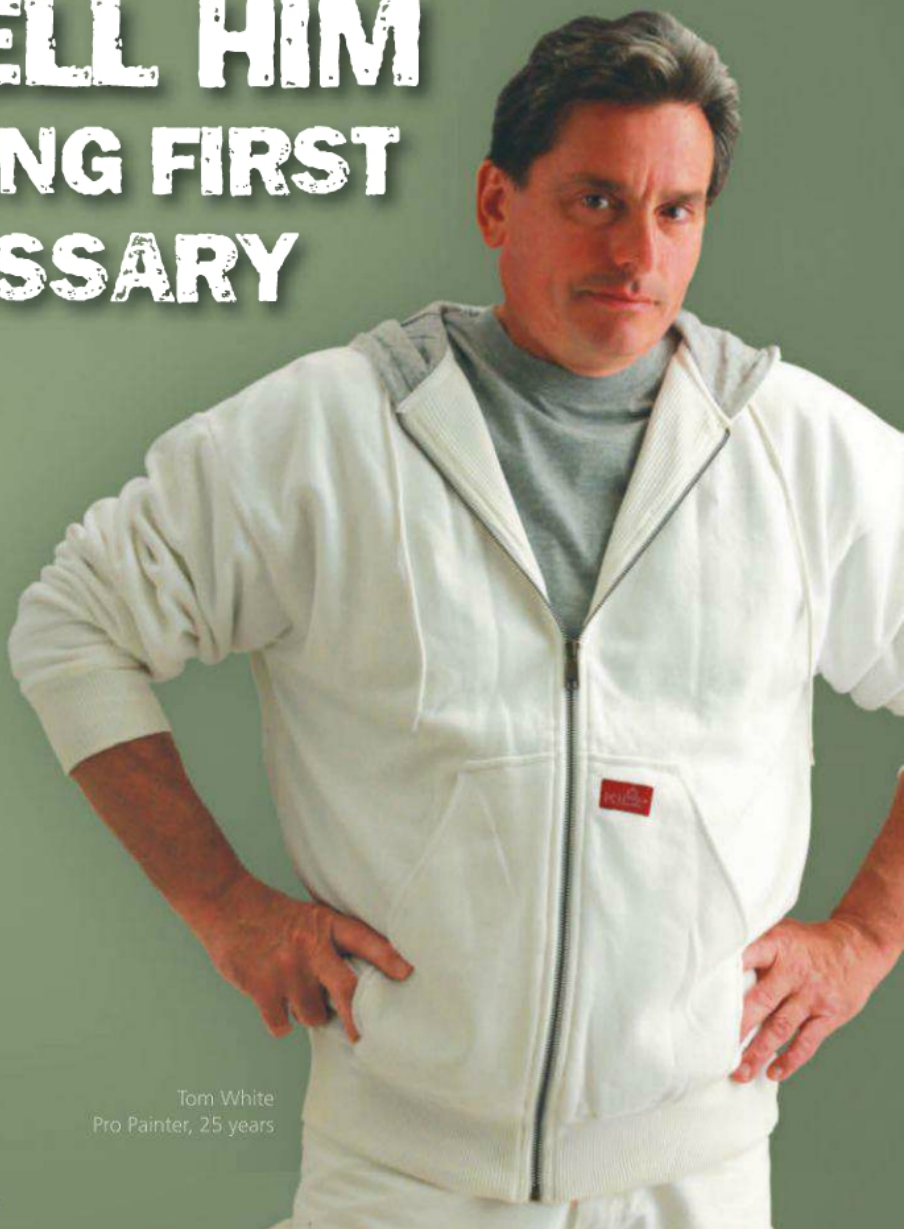
BuildingWorks: www.bwiny.org/pages/wr/bw.html
(212-727-2224)

Popular Mechanics would also like to thank DRYLOK®, FEIN Tools, FrogTape®, KILZ® Premium and MadGrip® Gloves for the materials they so graciously donated to this project.



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W

weekend

HOME ADVENTURE TECH SCIENCE AUTO



Who needs
crème
brûlée when
you can
have a charred
marshmallow?
Toast a few
over our DIY
fire pit,

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diy



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WATER-BALLOON
LAUNCHER
REVIVING
PLANK FLOORS

Home

BY ROY
BERENDSOHN



RING OF FIRE

BUILD A MASONRY FIRE PIT, BUT SKIP THE CONCRETE AND MORTAR. THEN ADD SOME RUSTIC LOG BENCHES. BY GEORGE RETSECK

M

y wife and I love lighting a big fire in the backyard to cap off a day of entertaining. But building a pyre on the lawn left an ugly charred circle that grew larger over time. It made me cringe the next morning; it was like a visual hangover. We also worried that a wind-blown ember could torch the nearby woods.

I considered building a traditional brick fire pit on a concrete footing, but that's no small undertaking or expense. The first step would be to dig a 30-inch-deep footing trench down through rocky soil. Then I'd have to get the concrete into the trench. Even if I opted to get the material delivered, it's not easy lugging it by wheelbar-

11

WEEKEND



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Talk with your doctor first. Make sure your heart is healthy enough to have sex. If you have chest pain, nausea, or other discomforts during sex, seek medical help right away.

In the rare event of an erection lasting more than four hours, seek immediate medical help to avoid long-term injury.

In rare instances, men who take PDE5 inhibitors (oral erectile dysfunction medicines, including VIAGRA) reported a sudden decrease or loss of vision, or sudden decrease or loss of hearing. It is not possible to determine whether these events are related directly to these medicines or to other factors. If you experience any of these symptoms, stop taking PDE5 inhibitors, including VIAGRA, and call a doctor right away.

The most common side effects of VIAGRA are headache, facial flushing, and upset stomach. Less common are bluish or blurred vision, or being sensitive to light. These may occur for a brief time.

VIAGRA does not protect against sexually transmitted diseases including HIV.

Take VIAGRA about one hour before you want to have sex. VIAGRA works for 4 hours. VIAGRA only works with stimulation.

Please see Important Facts for VIAGRA on the following page or visit viagra.com for full prescribing information.

*Data taken from a study of 228 men with ED who previously had success with VIAGRA. Of the 115 men who took VIAGRA 100mg, 35% had erections hard enough for successful intercourse at 14 minutes, and 51% of men at 20 minutes.

Individual results may vary.

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IMPORTANT FACTS

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IMPORTANT SAFETY INFORMATION ABOUT VIAGRA

Never take VIAGRA if you take any medicines with nitrates. This includes nitroglycerin. Your blood pressure could drop quickly. It could fall to an unsafe or life-threatening level.

ABOUT ERECTILE DYSFUNCTION (ED)

Erectile dysfunction means a man cannot get or keep an erection. Health problems, injury, or side effects of drugs may cause ED. The cause may not be known.

ABOUT VIAGRA

VIAGRA is used to treat ED in men. When you want to have sex, VIAGRA can help you get and keep an erection when you are sexually excited. You cannot get an erection just by taking the pill. Only your doctor can prescribe VIAGRA.

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VIAGRA does not protect you or your partner from STDs (sexually transmitted diseases) or HIV. You will need to use a condom.

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WHO IS VIAGRA FOR?

Who should take VIAGRA?

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- If you ever take medicines with nitrates:
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- If you use some street drugs, such as "poppers" (amyl nitrate or nitrite)
- If you are allergic to anything in the VIAGRA tablet

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Tell your doctor if you have or ever had:

- Heart attack, abnormal heartbeats, or stroke
- Heart problems, such as heart failure, chest pain, or aortic valve narrowing
- Low or high blood pressure
- Severe vision loss
- An eye condition called retinitis pigmentosa
- Kidney or liver problems
- Blood problems, such as sickle cell anemia or leukemia
- A deformed penis, Peyronie's disease, or an erection that lasted more than 4 hours
- Stomach ulcers or any kind of bleeding problems

Tell your doctor about all your medicines. Include over-the-counter medicines, vitamins, and herbal products. Tell your doctor if you take or use:

- Medicines called alpha-blockers to treat high blood pressure or prostate problems. Your blood pressure could suddenly get too low. You could get dizzy or faint. Your doctor may start you on a lower dose of VIAGRA.
- Medicines called protease inhibitors for HIV. Your doctor may prescribe a 25 mg dose. Your doctor may limit VIAGRA to 25 mg in a 48-hour period.
- Other methods to cause erections. These include pills, injections, implants, or pumps.
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POSSIBLE SIDE EFFECTS OF VIAGRA

Side effects are mostly mild to moderate. They usually go away after a few hours. Some of these are more likely to happen with higher doses.

The most common side effects are:

- Headache
- Feeling flushed
- Upset stomach

Less common side effects are:

- Trouble telling blue and green apart or seeing a blue tinge on things
- Eyes being more sensitive to light
- Blurred vision

Rarely, a small number of men taking VIAGRA have reported these serious events:

- Having an erection that lasts more than 4 hours. If the erection is not treated right away, long-term loss of potency could occur.
- Sudden decrease or loss of sight in one or both eyes. We do not know if these events are caused by VIAGRA and medicines like it or caused by other factors. They may be caused by conditions like high blood pressure or diabetes. If you have sudden vision changes, stop using VIAGRA and all medicines like it. Call your doctor right away.
- Sudden decrease or loss of hearing. We do not know if these events are caused by VIAGRA and medicines like it or caused by other factors. If you have sudden hearing changes, stop using VIAGRA and all medicines like it. Call your doctor right away.
- Heart attack, stroke, irregular heartbeats, and death. We do not know whether these events are caused by VIAGRA or caused by other factors. Most of these happened in men who already had heart problems.

If you have any of these problems, stop VIAGRA. Call your doctor right away.

HOW TO TAKE VIAGRA

Do:

- Take VIAGRA only the way your doctor tells you. VIAGRA comes in 25 mg, 50 mg, and 100 mg tablets. Your doctor will tell you how much to take.
- If you are over 65 or have serious liver or kidney problems, your doctor may start you at the lowest dose (25 mg).
- Take VIAGRA about 1 hour before you want to have sex. VIAGRA starts to work in about 30 minutes when you are sexually excited. VIAGRA lasts up to 4 hours.

Don't:

- Do not take VIAGRA more than once a day.
- Do not take more VIAGRA than your doctor tells you. If you think you need more VIAGRA, talk with your doctor.
- Do not start or stop any other medicines before checking with your doctor.

NEED MORE INFORMATION?

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row. Mixing it by hand also seemed like a backbreaker. So I abandoned the idea of traditional masonry. Investigating chimineas and steel fire rings at a nearby home center, my wife and I discovered the Fossil Stone Fire Pit from Natural Concrete Products, a \$500 kit of concrete blocks and a steel fire ring.

Much to my surprise, a buddy and I constructed the pit in 4 hours. When night fell, I kindled a big fire. Friends gathered, and I relaxed with a cold beer. The pit looked great and safely contained the fire without a burnt ring of grass the next day.

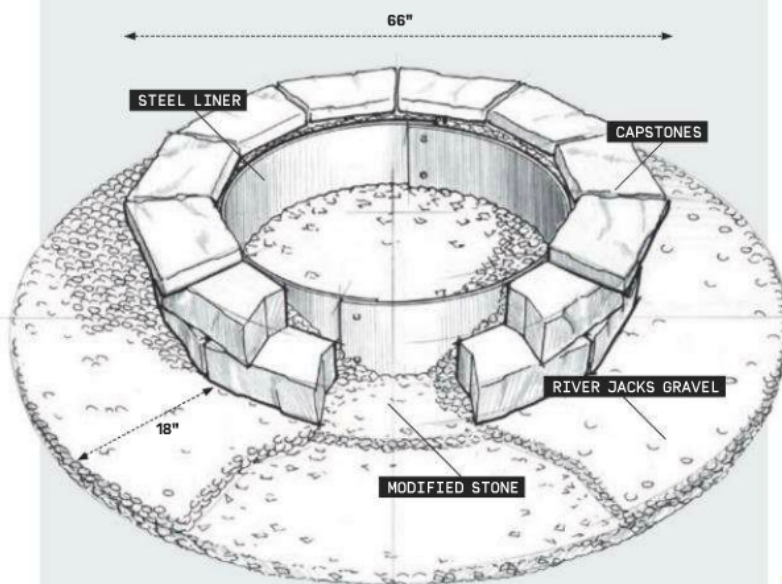
Prepare a Site

Here's what not to do: Build the pit under low-hanging limbs or power lines. Also, avoid putting it over or near a septic tank, leaching field, well head, or property line. Local laws will almost certainly require you to position a structure of this type a given distance from your neighbor's plot, not to mention your own house. Check the codes at the town hall or the fire department.

After my buddy—Roy Berendsohn, *POPULAR MECHANICS'* home senior editor—and I had located the ideal spot in my yard, we drove a stake at the approximate center of the pit, looped a mason's line around the stake, and then tied the line around a can of white landscape spray paint, with which I created a 102-inch-diameter circle. This is large enough to accommodate the pit, whose outside diameter is 66 inches, and a surrounding 18-inch band of River Jacks gravel.

To create a base for the pit and gravel, we dug a hole 4 inches deep bordered by the painted circle and dumped in enough crushed stone to fill a few wheelbarrows. (I used 2A Modified, a common road-building material in my area; check for something similar at your local stone

ASSEMBLING THE FIRE PIT



With crushed stone tamped and leveled, place the first layer of blocks using a tape rule placed on the center stake to measure the fire-pit radius. Use a torpedo level to check and adjust each block [1]. Bolt the fire ring together and place it in the pit [2]. Fill the gap between the fire ring and the wall with crushed stone [3]. Use masonry adhesive to attach each capstone [4].



5



6



7



8



9

MAKING HALF-LOG BENCHES

I wanted to install seating near the fire pit and thought a couple of rustic log benches would fit the bill. Since I heat my home with firewood, I always have a few logs on hand: The straightest of these became the seats.

I halved two logs lengthwise by driving several wood-splitting wedges into them. While I did this, Roy dropped a large pinch-point digging bar into the crack, holding the log in position and using the bar as a lever to complete the split [5].

Then we leveled and smoothed the flat surfaces using a Bosch planer, making a series of $\frac{1}{8}$ -inch-deep diagonal passes and then going straight down the log [6]. If you lack a planer, you could do this with a large belt sander and the coarsest-grit belt you can get. Sure, it would take longer, but it would work.

Notching the Base Logs

My favorite part of building half-log benches is making

the crescent-shaped notch in the base logs. It's surprisingly easy to do. We placed the seat facedown on the ground and held a base log perpendicular to the curved part of the seat [7]. Next, we made tick marks with white chalk, tracing the seat's curve, then connected the tick marks, forming an oval. We made side-by-side slices with a small chain saw (a Stihl MS 230 C-BE), gradually carving the crescent, then fine-tuned the curve with a stout wood chisel and hammer [8]. We chiseled and sawed as necessary, keeping in mind that the crescent doesn't have to be a perfect fit—just close enough to hold the seat securely. Last, we placed the seats around the pit [9].

yard.) After raking the stone to a depth of about 2 inches, we compacted it with a hand tamper.

For aesthetic reasons and to ensure the fire-pit blocks align properly, it's important to build the pit's walls on a level surface. So we marked a 68-inch-diameter circle (a couple inches wider than the outer wall of the pit) on the compacted stone, then used a 4-foot mason's level to check the surface. We weren't as fussy about leveling the rest of the stone, since it would be covered just by the gravel.

Build the Pit

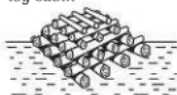
The fire-pit wall consists of two layers of wedge-shaped concrete blocks, each with a clearly marked top and bottom. The inside edge of each block sits 24 inches from the center of the pit. After we positioned one block, we placed each successive one snugly against the next. The process was simple, like completing a puzzle, with the last block of the first tier neatly completing the circle.

Before installing the second layer, we placed a straight piece of lumber on top of the first one and used the level to make sure we were on the mark. We laid up the second tier, staggering the blocks to ensure that the seams didn't line up; this improves the wall's stability. Next, we bolted together the two steel pieces that form the fire ring, placed it in the pit, and tapped it with a rubber mallet to get it to settle into the crushed stone. After backfilling the space between the ring and the inside of the wall with more crushed stone, we added the cap, first laying the pieces in position and then gluing each one into place with a quarter-size glob of masonry adhesive. Finally, we ringed the pit with gravel.



teepee

log cabin



TEEPEE VS LOG CABIN To make a teepee fire [far left], stack kindling, then stand wood over it. The vertical wood forms a chimney, and the draft through it produces a quick, hot fire that looks pretty and makes a small pile of embers. The log cabin, or ladder, burns slowly and is better for cooking. Tip: The teepee's embers can start a log cabin fire.

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Robert and Marigold Moritz get ready for launch. We wish they were wearing eye protection!

WATER-BALLOON LAUNCHER

Early Adopter

BUILD A SIMPLE A-FRAME TO FORM A STURDY BASE FOR HURLING LIQUID-FILLED "BOMBS" A LONG, LONG WAY.

BY ROBERT AND MARIGOLD MORITZ

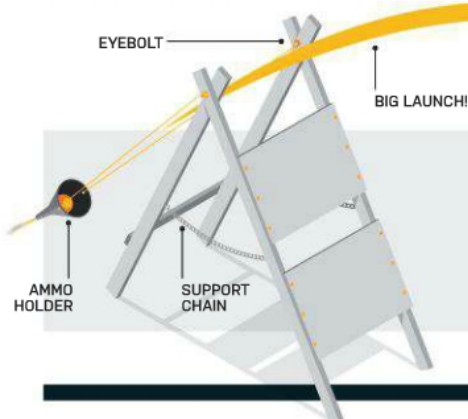
DEGREE OF DIFFICULTY

3/10

AGES: 5+

BUILD TIME:
3 HOURS

PARTS COST:
ABOUT \$55



Materials

- ▷ Four 6' lengths of 1 x 2 pine (legs)
- ▷ Two 3/4" plywood pieces, 18" x 48"
- ▷ One 46" length of 1 x 2 pine (crossbeam)
- ▷ Two 5/16" x 4" eyebolts with wingnuts

- ▷ Six washers, 1" outer dia., 3/4" hole
- ▷ 14 1 1/2" No. 8 wood screws
- ▷ Four 3/4" x 2" eye lags
- ▷ Four 2" carabiners
- ▷ Two 32"-long chains
- ▷ Funnel, 6" top dia.

- ▷ Two rubber grommets, 1/2" inner dia.
- ▷ 6" old garden hose or plastic tubing
- ▷ 24" length of rope
- ▷ Fender washer, 2" outside dia., 3/4" hole
- ▷ 4' surgical tubing

Build the frame

1. Drill a 5/16-inch hole in the center of the 2-inch side of each leg, 3 inches from one end.
2. On the narrow side of two legs, mark 12 inches from the end opposite the holes. Align the bottom of a plywood piece with the marks, hold the outer edges of the plywood and the legs flush, and drill three 3/8-inch pilot holes on each side, 3/8 inch from the edge. Screw the plywood to the legs. Mark the legs 6 inches from the top of the plywood. Line up the bottom edge of the remaining piece of plywood on the marks and fasten it to the legs. This is the launcher's front.
3. Lay the other two legs on a level surface, parallel and with the outer edges 46 1/2 inches apart. Mark the narrow side of each leg 18 inches from the bottom, line up the crossbeam with the marks, and fasten it with one screw on each side. This is the back.
4. Connect the two assemblies by fitting the narrower one inside the other, lining up the 5/16-inch holes and putting the eyebolts through the holes, with the eye on the inside. Use three washers per side, one each between the eye and the inside leg, the two legs, and the wingnut and the outer leg.
5. Screw an eye lagbolt into each leg, 36 inches from bottom. Use the carabiners and chains to connect the eyebolts.

Make the water-balloon holder—and bombs away!

6. Drill two 3/8-inch holes opposite each other into funnel, 1 inch from top; fit grommets into holes. Slide 6-inch piece of hose onto rope; push rope's ends through narrow end of funnel and hole in fender washer. Tie the ends together.
7. Tie two 24-inch lengths of surgical tubing through the grommets and the eyebolts. Stand behind the frame, grasp the balloon holder's handle, and pull down at an angle. Load the funnel with a water balloon—and let it fly.

Home Clinic

BY ROY BERENDSOHN

 PHOTOGRAPH BY
KARL JUNGEL


Drawing a Bead

I want to install traditional bead-board wainscoting, and from what I've read about it, some people remove the drywall behind the wainscoting and install ½-inch plywood. Others fasten the bead board directly to the drywall. Which is better?



wainscoting (¾- to ¾-inch) or when the material is installed in laundry or mud rooms, where walls tend to take a beating. On the other hand, this method requires a lot more work. Removing the drywall is messy and dusty, the plywood must be cut to fit, and the debris has to be carted away. Another thing to consider is local fire codes: Some municipalities take a dim view of removing drywall and replacing it with the more combustible plywood. Check with your town before you add the plywood backing.

The fastest and least expensive wainscot installation is the glue-and-nail method. You apply panel adhesive to hold the bead board in position and then nail it to the drywall with a fine finish nail or even a pneumatic pin nail. "The glue-and-nail method is a great way to go," Joe Truini, a *POPULAR MECHANICS* contributing editor, says. "It's not as strong as backing the wainscoting with plywood, but it's plenty durable for most cases."

A chair rail and baseboard trim can also increase holding power—and they look good, too. Truini advises fastening these to wall studs to clamp the bead board firmly in place. Use as large a finishing nail as you can that will not run

There's no single right way to install bead-board wainscoting. It all comes down to your budget and how much time you want to spend on the job.

Some professional finish carpenters remove the drywall behind the wainscoting and screw ½-inch plywood to the wall studs. The plywood provides a solid, consistent base, which is especially helpful for thick

GLOSSARY

WAINSCOT

The word for lower-wall paneling derives from the unlikely pairing of two words that mean "wagon partition." The former comes from "wain," which is of Middle English origin; the latter is a derivation of the Middle Dutch "scot," or "schot."

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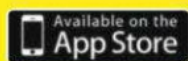
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the risk of splitting the baseboard or the chair rail. A large nail will increase the clamping effect.

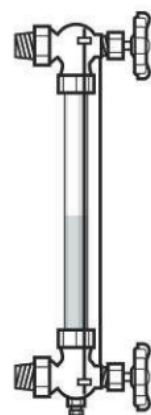
Full Steam Ahead

Our house is heated by an old-fashioned steam boiler that works fine, but because the glass tube that's supposed to allow us to read the boiler's water level is so dirty, we have no idea how full or empty the boiler is. Before the heating season starts, can I remove the glass for cleaning?

Late summer or early fall is the ideal time to take care of this problem. The thing you're referring to is known as a sight or gauge glass, and it's designed to be flushed clean by steam or removed and cleaned with a bottle brush. It consists of two valves connected by a glass tube. The top and bottom valves are above and below the boiler's water level, respectively. Both valves are kept open, so water in the boiler rises up the glass tube and stops at the point where water evaporates into steam.

Aside from providing information about water level, the glass also tells you about the condition of the water—whether it's surging up and down because of turbulence in the boiler (not good), filled with rust from radiators or the boiler itself (also not good), covered with a layer of oil introduced into the heating system by a repair job (extremely not good), or nice and clean and quietly being converted to dry steam vapor that makes its way silently and efficiently into the home's pipes and radiators (very good). The sight glass is brilliant in its design simplicity.

To clean the glass yourself, first put on a pair of leather work gloves to avoid scalding. Fire the boiler so it reaches its operating temperature, turn the bottom handwheel (known to plumbers as a gauge glass cock) to prevent hot boiler water from entering the gauge glass. Next, open the petcock, which is the little valve below the handwheel. This will cause steam to flush the glass clean. After you've completed these steps, perform them in reverse: Close the petcock and open the handwheel to allow boiler water back into the gauge glass. If that doesn't do the trick, close both the upper and lower handwheels, remove the gauge glass, and use a small bottle brush to clean it. This job can be a bear, just so you know. Many times the glass is stuck in place, and it breaks when you try to remove it. Even if you get the gauge glass out, you'll need to replace the gaskets that seal it to the



A gauge glass shows a boiler's water level—and the level of the water's clarity.

WEEKEND

Don't Be an Idiot

TAKE YOUR TIME TO AVOID THE TINES



Any DIYer who's ever inadvertently hammered his or her thumb knows that pain is a great teacher of what *not* to do. That notion applies in this case: Some years ago I was working outside on a cold autumn day clearing brush, cutting up downed branches and removing leaves. Lying on the ground around me were a shovel, various rakes, and

other tools. As I stepped backward, I felt a strange sensation underfoot; a second later, the handle of a bow rake whacked me in the face. I had leaned the tool against a tree, tines facing out, in the perfect position to be stepped on. The lesson, painfully learned: When working with a bow rake, remember to stand it tines facing in.

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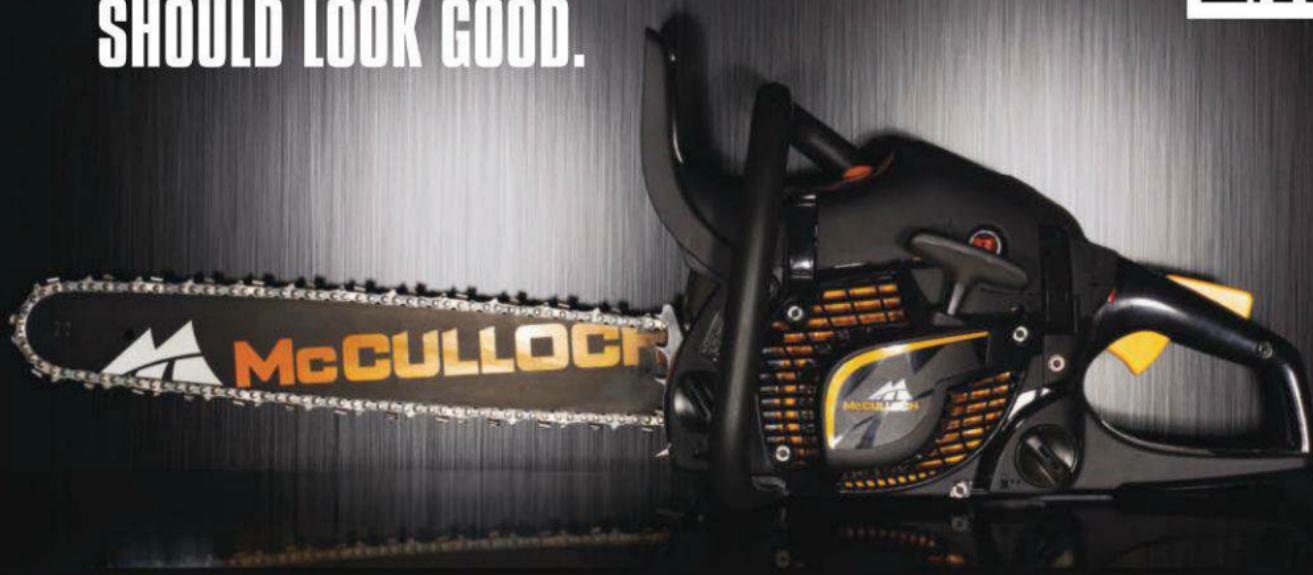
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valve body. Fortunately the gauge glass, the gaskets, and the cock fittings are still widely used, so finding parts at a plumbing supply store should be a snap.

If the water in the glass is rusty, you've got problems. Rust can lead to clogged valves and inefficient operation. It may be time for you to ask a plumber who's familiar with steam heat to evaluate your boiler, pipes, valves, and radiators. You can find this contractor locally or visit heatinghelp.com, a website run by Dan Holohan, the nation's leading authority on steam heat.

Sloppy Fit

We have metal electrical boxes in the basement, and the cable fittings in them are much smaller than the holes in the side of the box. The fittings don't appear to fasten the cable to the box.

Other boxes have no fittings; cables come in and out through holes in the box. Even the doorbell transformer mounted on the service panel is loose. I suspect these problems are hazardous—are they?

Dangerous? As they say in Minnesota, "Ya, you betcha." Have an electrician inspect the home's wiring inside and outside. If the workmanship is bad where it's visible, you can only imagine what's going on where it's concealed.

Now the good news. What you describe is easy to repair. An electrician will cut power to the aforementioned electrical boxes; undo the splices inside; withdraw the cables and mount proper-size cable clamps on the box's openings (called knockouts); push the cable back into the box; and redo the splices. In some cases the electrician will install reducing washers in the knockouts. These washers (sometimes referred to as donuts by electricians) allow a smaller cable clamp to be used in a knockout that is too large. These may look strange, but they're legitimate. As for the doorbell transformer, that might be just a loose mounting screw.



Assuming that the electrical inspection turns up nothing more serious than what you've described, you're looking at a couple of hundred dollars of corrective work. On the other hand, if the electrician finds nicked or melted wires, burned splices, undersize wire, or electrical boxes that are too small for the number of wires in them, you can expect a bill that's anywhere from two to five times that amount.

Scratched Corian

My Corian countertops have taken a beating over the years. Is it possible to remove scratches from them, or will I need to replace the counters? If the scratches can be removed, how do I go about it?

Corian is tough stuff but not scratch-proof, as you've found. The material, which first hit the market in 1967, is made of acrylic resins and aluminum trihydrate, a common industrial powder used in everything from flame retardants to paint. Luckily, scratches can be polished out of Corian and other so-called solid-surface materials. Contractors who restore natural stone surfaces are almost always versed in working with Corian.

If the scratches are minor, try polishing them out yourself. A DIY counter-repair kit costs about \$14 and contains ultrafine abrasive polishing pads (for example, see the products at micro-surface.com). To use the pads, first thoroughly clean the counter and then sand back and forth along the line to remove the scratch. Then switch to the pad with finer grit and work it across the surface, perpendicular to the scratch, until the counter is smooth. Whatever you do, don't use regular sandpaper, which is too coarse; the grit is only as fine as 600 or 800, compared with the 12000 grit you get in the DIY scratch-removal kit.

Faded Beauty

We have a thin-plank floor in our kitchen. When we moved a rug under the table, we found that the adjacent exposed wood had faded from sunlight while the floor under the rug was still a rich brown. Can the floor be refinished?

That is a common problem. First, check around to see whether you have a few planks somewhere left over from the installation. These are always good to keep tucked away, because you may need them for a repair or to show to a floor refinishing contractor. If the ends or the edges of the planks look like plywood topped with a thin piece of solid hardwood, the chances are good that the floor can be sanded and refinished by a professional, either eliminating the color discrepancy or reducing it to the point that you'll be the only person who will know notice the difference.

If the plank looks like a piece of fiberboard topped by a paper-thin layer, you're better off putting that rug back and replacing the entire floor at some point. The body of a thin-plank laminate floor is fiberboard sandwiched between two pieces of resin-coated paper. The bottom paper keeps the plank from absorbing moisture from below. The top paper is printed to look like wood (or stone) and coated with a tough plastic wear layer, such as melamine. If you tried to sand this, you'd cut through the wear layer and the decorative top paper and the floor would be ruined.

On the other hand, engineered wood plank flooring is like plywood. Several layers of wood veneer are bonded to a top layer that's about $\frac{3}{16}$ inch thick or so. A professional floor refinisher using modern floor-sanding equipment can shave off the top layer of wood without the risk of cutting completely through it. Then the fresh surface can be refinished. An experienced floor contractor can leave a surface that's virtually as good as new. **PopMech**



**GOT A HOME-MAINTENANCE OR REPAIR PROBLEM?
ASK ROY ABOUT IT.**

Send your questions to pmhomeclinic@hearst.com or to Home Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we cannot answer questions individually, problems of general interest will be discussed in the column.

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Adventure



BY ALLEN ST. JOHN



RELISH GRAY DAYS

"Bass are low-light predators," says Kevin VanDam. Go fishing "when the wind is blowing or it's cloudy, or just early in the morning or late in the evening." In low light a bass may chase a lure that is 20 feet away.



AGITATE YOUR FISH

Bass don't always bite because they're hungry. "A lot of times it's a straight aggressive reaction because you annoyed him," says VanDam. Drop the lure near the fish and move it erratically.



REEL IT IN SLOWLY

"Most amateurs fight a fish way too hard from the get-go," 2009 Bassmaster Classic champion Skeet Reese says. "They never stop reeling and they break a fish off." But don't allow the line to go slack. That can let the fish spit the lure.



... OR JUST CHEAT

The Alabama five-lure rig was banned from big tournaments earlier this year. It just made catching bass too easy. Now, there's no need to tell your fishing buddies that, but do check local rules on multilure rigs.

BASS BEATERS

FIVE TIPS TO MAKE A GOOD FISHERMAN BETTER.

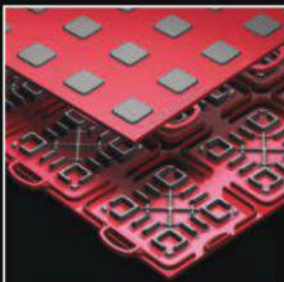


A lot of guys sort of know how to catch large- and smallmouth bass. But the anglers in Bassmaster pro tournaments obsess over the details because landing one extra fish can mean big money. The first thing amateurs do wrong, they say, is fall in love with their favorite fishing spot and go-to lure. Remember the 7-pound bass you caught in that magical bay using a plastic worm while wearing your dad's lucky Brooklyn Dodgers cap? Coincidence. "I won't spend more than 10 minutes in the same spot fishing the same way, unless I've gotten a positive response," says Kevin VanDam, a seven-time Bassmaster Angler of the Year. Here are four more tips from the best. **PopMech**

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**Popular Mechanics
INSTRUCTIONS**
1 THE BASICS

For hobbyists who want to create their own electronics from scratch, there comes a time in every project when two metal surfaces must merge. Solder, which changes from a flexible solid to a liquid, then back to a solid in seconds, is the magical metal glue that makes this happen. Solder can also be a frustrating mess. For reasons both aesthetic and functional, you'll want to learn how to work with it cleanly and neatly, because sloppy soldering means your project might not work.

The best solder for electronics is 60 percent tin and 40 percent lead and filled with rosin, a pine-tree secretion that slows oxidation to help the metal flow.

Tech

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SOLDERING**

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AND GLUING POWERS OF SOLDER TO
BUILD YOUR OWN ELECTRONICS.**

2 MEET THE MATERIALS

Printed circuit boards (PCBs) connect together electronic components (capacitors, resistors, LEDs, microcontrollers, sockets, etc.). Solder gives those components structural and electrical footholds at the spots where they're mounted, called pads. It's important that these surfaces start out clean, so wipe the PCB with a nonabrasive scrubber.

**SAFETY
TIP**

Try not to let that metal flow onto your hands—not only is the solder hot, the lead is toxic. Wash your hands after soldering so you don't leave any residue on your skin.

Rise from the Ashes



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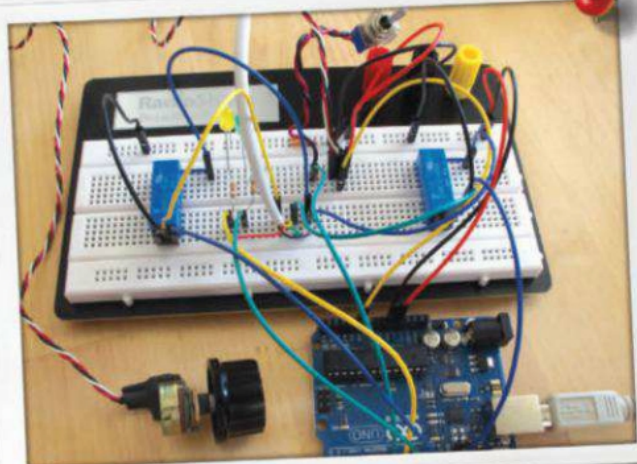
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Time-lapse photography is a great way to watch the world move at a different pace. By speeding up scenes of clouds billowing in the sky, plants growing or sunrises and sunsets, we notice patterns that we might otherwise miss. They also look really cool!

The technique is simple: use a camera to capture images at regular intervals, from every few seconds, to every few minutes, or longer, depending on the subject and the desired effect. Then assemble those images into a movie and play them back at typical—and much faster—film or video speeds.

Digital cameras make shooting time-lapse videos easy, but you need a way to control the camera. An intervalometer is a device that triggers a camera's shutter at regular intervals. You can purchase one at a camera shop, but it's also the perfect job for an Arduino plus a few other parts, all available at RadioShack.

An Arduino is a programmable device that can add all sorts of interactive features to your electronic project. If you're new to working with an Arduino, this is a great way to learn about how it reads input from buttons, switches and dials, and sends outputs to control your camera. We'll provide the program for you!



Our intervalometer can connect to a camera that has a 3-conductor 2.5mm remote input. This is found in many DSLRs, such as the Canon T3.

Adjusting a dial, which is attached to a potentiometer, sets the speed. Blinking LEDs will tell you how fast the camera will capture images. When you have a speed you like, switch the device from “standby” to “go” to start shooting!

Once you’ve shot some time-lapse footage, you’ll download the image files to your computer. There are a number of programs that will assemble the images into a movie, such as QuickTime Pro or the open-source (but less user-friendly) FFmpeg.

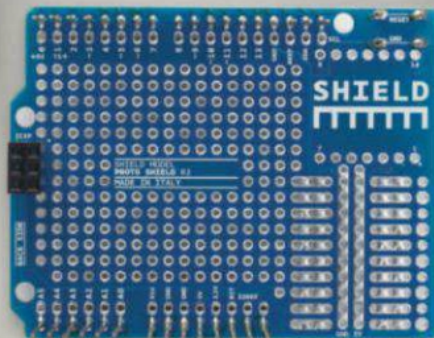
Complete instructions for building your own intervalometer can be found online by following the QR code below, or going to www.RadioShackDIY.com.

This project is just one way you might control your camera with an Arduino. Other possibilities include hooking up an infrared motion detector and modifying the program to snap a photo whenever any backyard wildlife comes within range.

By Ken Murphy

ARDUINO-POWERED TIME-LAPSE FEATURES THESE RadioShack PARTS:

Arduino Proto Shield



9V Snap Connector



Pushbutton Switch SPST 3-Amps



Size M Coaxial DC Power Plug



Energizer 9V Battery

To see “how-to” video footage for this project and explore other great creations, visit RadioShackDIY.com

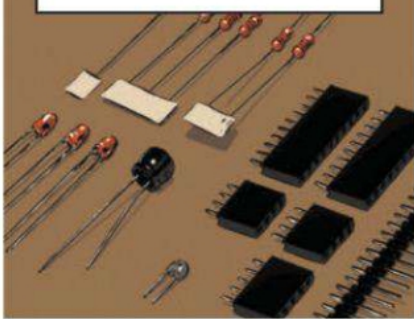


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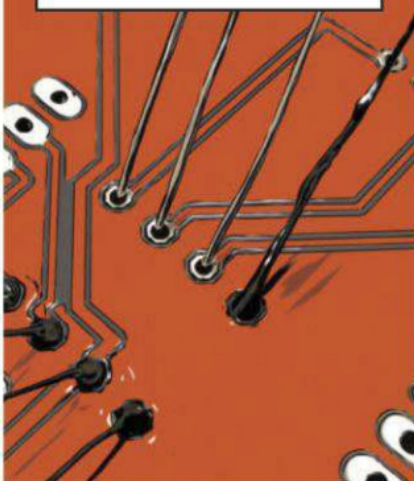


**3 COMPONENT LEADS**

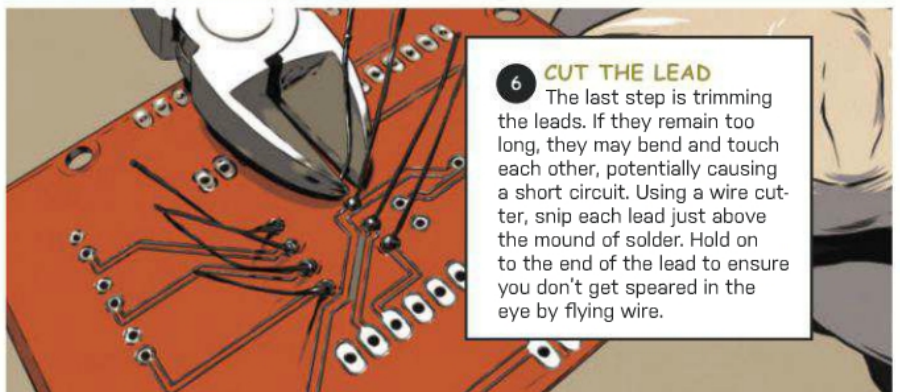
The wires sticking out of components are called leads. Some parts, such as microcontrollers, come with rigid leads that align with the pads on the PCB, and others, such as resistors, come with longer leads that bend to fit. Some parts have one lead, some two, some 28 or more.

**5 CHECK CONNECTIONS**

A perfect connection will look like a small bump around the lead and will completely cover the pad. If some of the pad is still exposed or the connection is flat, you haven't used enough solder, and you may end up with an incomplete connection. The fix is simply to add more solder, but not too much—that could create a connection where you don't want one, shorting the circuit and directing electricity down the wrong path.

**4 ADD COMPONENTS TO THE BOARD**

To connect a component to the board, push its leads through holes in the pads—only one lead goes into each pad—and bend them about 45 degrees to keep the component from falling out. Next, hold the iron like you would a pencil and press it against the pad and lead for 1 second. Then push about 1 to 3 mm of solder between the lead and the pad, where it will melt against the heated components. Hold the tip steady for another second or two so the solder has a chance to flow around the lead. It's key to heat the components themselves, not the solder directly, which can cause a cold joint; components that aren't hot enough won't bond to the solder properly, leaving the joint weak.

**6 CUT THE LEAD**

The last step is trimming the leads. If they remain too long, they may bend and touch each other, potentially causing a short circuit. Using a wire cutter, snip each lead just above the mound of solder. Hold on to the end of the lead to ensure you don't get speared in the eye by flying wire.

HOW TO JOIN TWO WIRES

JOIN WIRE TO WIRE Solder is also great for fusing wires. Match each wire's gauge to the markings on a wire stripper and remove about 3 mm of insulation from its end.

TIN THE ENDS Heat the exposed wires with the soldering iron and coat the ends with a thin layer of solder—a process called tinning—to ensure the wires form a proper connection. Then join the wires by pressing the iron to both wire tips, melting them together. Once the solder has melted, remove the iron and hold the wires still until the metal cools. Then you—and your wires—are set.

**CLEANING THE TIP**

Because a soldering iron heats to almost 400 F, the tip oxidizes quickly, creating solder rust that blocks the flow of heat. So before soldering each connection, use a wet sponge to clean the tip of the iron [it's clean when it shines] to remove any buildup.

SUPPLIES

Soldering is an affordable art. You can set yourself up with a full tool kit for less than \$30.

**SOLDERING IRON**

You don't need anything fancy. A pencil soldering iron between 15 and 40 watts is fine. (\$6)

**SOLDERING-IRON STAND WITH SPONGE**

This cleans the iron and keeps it from rolling onto your lap when you're not soldering (not fun). (\$5)



FLUSH CUTTER
You want a small one, about 4 inches, that can cut right up against the board. (\$3)

**SOLDER**

To avoid a goopy mess, don't buy solder that is too thick—about 0.32-inch diameter is best for electronics work. (\$6 for a small roll)

**WIRE STRIPPER**

A good one is easy to use and can fit many wire sizes. (\$4)

BLINKING LED KIT

For an afternoon project, look for a kit that comes with components and the PCB. (\$9)

WEEKEND

ICONS BY MARTIN LAKSMAN

**DigitalClinic**

BY
RACHEL Z. ARNDT

PHOTOGRAPH BY PHILIP FRIEDMAN

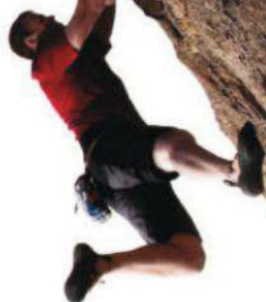
Direct Connections

I noticed my friend beaming a video from his phone to another friend's phone, but neither device was connected to a wireless router. How is this possible?



Your friends are probably using Wi-Fi Direct, a relatively new standard from the Wi-Fi Alliance that allows you to share content—including big files such as movies—without an Internet connection. Unlike conventional Wi-Fi, which is primarily used for getting online, Wi-Fi Direct is intended for sharing media across platforms and doesn't require routers or access points. Its closest analog is old-fashioned ad hoc

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DIY TECH / DIGITAL CLINIC

networking, an early Wi-Fi option that linked two or more devices directly—without stopping at a router along the way. According to Greg Ennis, technical director of the Wi-Fi Alliance, Wi-Fi Direct updates the ad hoc concept. “Ad hoc networking doesn’t really support the latest Wi-Fi advances,” he says. Wi-Fi Direct is easier to set up, more secure, and way faster—it can move data at up to 250 megabits per second; traditional ad hoc is limited to 11 Mbps. Wi-Fi Direct is also significantly faster than Bluetooth, which typically tops out at 3 Mbps, and it has a longer range (200 feet to Bluetooth’s 30 feet). So for a quick and easy transfer of a big file, it’s definitely the way to go.

But how do you know if your device has this particular Wi-Fi flavor? There are more than 1000 Wi-Fi Direct-certified products (you can check them out on the Wi-Fi Alliance’s website), including phones, printers, computers, and more—but a Wi-Fi Direct network requires only one of the participating devices to have the certification. Because the Wi-Fi Direct standard has WPA2 data encryption built in, forming a connection requires authentication from each participant in the network. To get permission, one device must ask the other for access; the second device must then actively allow the network to form. With a Wi-Fi Direct-certified printer and Wi-Fi-certified computer, for instance, that generally means pressing a button on the printer and clicking “accept” on the computer. With smartphones, accepting may just mean tapping “okay” on the screen. (And don’t worry about accidentally beaming scandalous photos or anything else you don’t want others to see later on—the sharing ends as soon as the Direct link is broken.)

Right now, Wi-Fi Direct is best for things such as photo sharing among a group of people or for streaming content, such as music, from one device to another. The Wi-Fi Alliance is also touting Miracast, the latest use of the technology, for screen sharing—beam directly from your phone or tablet to your TV, for instance. For now, though, your best bet on getting in on the video sharing is picking up a Wi-Fi Direct-certified laptop (HP has one) or a phone such as Samsung’s Galaxy S III or the LG Lucid.

Doctoring eDocuments

I want to read PDFs and Word documents on my e-reader, but when I transfer them to the device, they end up tiny and illegible. Is there a way to format my documents to make them more readable?

The trick to making your documents cooperate with your e-reader is getting them to act as if they had reflowable layouts like e-books. The reason you can easily change an e-book’s font and size is because its format—ePub, often, or Amazon’s proprietary KF8—allows the layout to change based on the screen, much as websites do. In other words, the text can reflow so the layout is relative to the size of the screen, not a hypothetical piece of paper. Because word-processing documents and PDFs are formatted for a specific page size, they can’t do that. So when you put a PDF meant to be printed on your e-reader, it acts as if the screen is a piece of paper and the text ends up tiny.

The specific fix depends on the type of e-reader you have, but you’ll probably need to use a word-processing and reformatting program, such as Calibre, a free application created by developer Kovid Goyal, to get your document e-ready. Calibre imports documents and does its best to lay them out for your specific device. If you’re just trying to get a bunch of documents onto your e-reader quickly and you don’t mind a few layout oddities, Calibre should be good enough. But if you’re not satisfied by the program’s guesswork, you’ll have to format the text yourself using a word-processing program such as Microsoft Word. Using the software, change the paper size to match the e-reader screen, place manual page breaks where you want them, and choose a good font—Gentium Book Basic, size 12, works well, and the font is available for free in Google’s web-fonts database. (Kindle offers an email-based service to do this reformatting for you, but formatting manually will work too.) Once you’ve reformatted your document manually to fit your e-reader screen, save it as a PDF. It won’t be reflowable, but it will fit your e-reader exactly because



TECH EDITOR RACHEL Z. ARNDT ON FEMTOCELLS

Bringing to life a cellular dead zone with a femtocell—a small cellular base station—can seem miraculous, if not cheap. But with some strategic badgering [and patience], you may be able to convince your service provider to give you one of the devices gratis.

you've already done the formatting for your specific screen. Overall, the process isn't quite as simple as an automated tool such as Calibre or Kindle's converter, but after you've done it once, you can save the template to make the process easier the next time.

Cellular Hotspot

I've been complaining about my cell reception for years, and my provider finally gave me a femtocell. Does this mean other people can now mooch cell service from me?

Technically, no. A femtocell is essentially a small cellular base station. When deployed by a cell-service provider, it acts like a mini cell tower, routing your calls and phone data over your Internet connection. But that doesn't mean your new mini cell tower is available to the general Pandora-and-Hulu-streaming public. When your cellphone provider gave you the femtocell, the company likely had you register the numbers you want to have access to (though some companies, such as Verizon, give you the option of keeping the network open). Because a femtocell uses your broadband connection for backhaul (i.e., the link between it and the phone and data networks), keeping access limited might be in your best interest; it prevents freeloaders from siphoning your bandwidth and pushing you past your monthly data caps. On the other hand, it would take a lot of freeloaders dealing with pretty big files to suck up all of your bandwidth (a call itself takes up just tens of kilobits per second). Plus, people with unregistered numbers won't even know your femtocell is there.

While the femtocell solves *your* problem, it doesn't solve the larger issue of cellular dead zones. In the past decade, says New York University professor of electrical and computer engineering Sundeep Rangan, service providers have focused more on building new operator-installed cells than on giving out femtocells. But because these cells are limited, and data use per person is climbing, companies are struggling to keep up, hence the need for femtocells. If deployed properly—and if customers are willing to shell out \$200 or \$300 for a unit—a femtocell could be a good solution for the individual, by providing better reception, and for all cellphone users, by taking a bit of the burden off the overall network. "The question," Rangan says, "is whether companies can get enough incentive for customers to use them," thereby opening up space on regular cellphone towers. And, he adds, "if people deploy femtocells, operators won't have to supply the backhaul connections to them, and they don't have to maintain them either," thus relieving some of the constant pressure for providers to build more towers to support their growing user bases. In other words, though femtocells would benefit everyone—easing the burden on providers and giving customers better service—the technology has yet to catch on in the mainstream. It might be the high price tag, which, with enough complaining to your provider, you may be able to get around. **PopMech**



GOT A TECHNOLOGY PROBLEM? ASK RACHEL ABOUT IT.

Send your questions to pmdigitalclinic@hearst.com. While we can't answer questions individually, problems of general interest will be discussed in the column.



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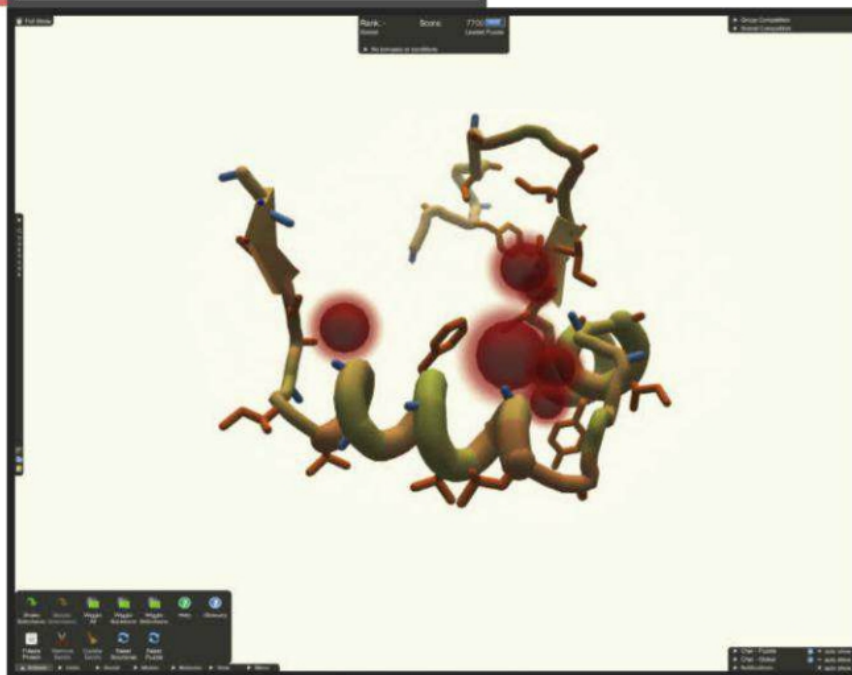
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WELCOME TO THE FOLD

ONLINE GAMING MEETS THE LABORATORY IN FOLDIT, A VIRTUAL WAY TO SOLVE REAL-WORLD BIOMEDICAL PUZZLES.

Last year, two teams of gamers co-authored a paper describing an HIV-related protein that had long stumped scientists. Not only did they puzzle out the protein's elusive shape, they did it in just three weeks. Their scientific method: Play a multiplayer online game called Foldit.

Protein folding is one of the hardest computational problems in biology. The get-it-done chemicals of life, proteins power muscles, transport signals through the brain, and defend against germs. A protein's function partially depends on how its long

chains of chemical building blocks fold into a compact and chemically stable shape. And determining that shape can lead to new treatments for diseases such as cancer, AIDS, and Alzheimer's. Surprisingly, it seems that teams of human beings motivated by curiosity and competition might do this better than the most sophisticated computers.

To play, gamers wiggle, shake, and pull digital models of proteins into new shapes—the more compact the shape, the higher the score. People who cooperate tend to be most effective. "You don't find many soloists among the top scorers," notes Doreen DeSorbo, a Web designer and a global moderator for the game. Now Foldit players have been asked to design a new protein—one that will bind to a flu virus and stop it in its tracks. Get started by downloading the game software at fold.it/portal. **PopMech**

FOLDIT GAMEPLAY

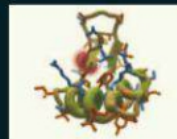
FOLDIT PLAYERS MANIPULATE PROTEIN CHAINS USING MOVES LIKE THESE:

REBUILD Tests alternative shapes for tough protein segments.

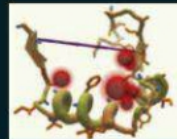
WIGGLE Settles the chain to compact it, like shaking uncooked pasta in a box.



SHAKE Jiggles the protein's side chains so they don't bump each other.



RUBBER BAND Creates a link that draws two sections together during a wiggle.



FREEZE Immobilizes just one part of a protein.

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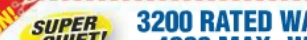


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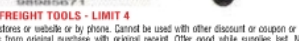


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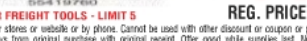


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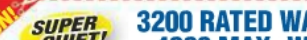


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BY BEN WOJDYLA

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THE NORTH AMERICAN JUNKYARD IS A MAGICAL PLACE IF you're a penny-pincher, gearhead, professional widget collector, or just bored out of your mind in need of something cheap to do. Most upstanding citizens ignore this last stop in the automotive life cycle and choose new parts from a nice, safe dealer installed at exorbitant rates. If, however, you like to add a dash of adventure to your car repair, you should definitely check out a junkyard before shelling out for new parts. For the uninitiated, these places can be intimidating, but that needn't be the case. A good automotive recycler offers a priceless mechanical education as well as a boatload of inexpensive parts.

PICK YOUR POISON

Junkyards come in two styles—you-pick and full-service. At you-picks, customers bring their own tools and personally wrestle parts from derelict cars. Full-service yards will pull requested items and deliver them to the front desk, where payment is collected, though this convenience comes with added cost. My preference is definitely the do-it-yourself type, which offers endless opportunities for mechanical exploration. Plus, their low operating costs mean these businesses are popping up all over the place lately.

When you've found a yard, call ahead to find out what they specialize in. Some yards deal primarily in domestic-brand cars, others in Japanese, German, high-performance, or vintage. Most are generalists and stock what the market both supplies and demands. If you have a rare car, ask if they have your model before spending time wandering around. They might know; they might not. The likelihood of finding that window-crank handle for your Triumph TR7 is pretty low because the supply and demand aren't there. Conversely, you'll probably find piles of pickups, vans, midsize sedans, and econoboxes. Wrecks come and go regularly, so try to find out when the new junkers come in—they have the best selection of parts. Remember, these places buy crashed and abandoned cars to recycle them, so selling their parts is a happy bonus.



Junkyards have evolved. Now they're an environmentally friendly stop on the way to the shredder. Liquids such as coolant, oil, brake fluid, gasoline, and washer fluid are extracted by workers for recycling or reuse. Metal rims are welded together as stable vehicle stands so folks can safely pull parts before cars are crushed.



GLOSSARY

FLUFF

The mix of plastic, rubber, textiles, and sound deadeners that results from grinding a car for metal recycling. It's used at landfills as daily cover to prevent garbage from blowing away.



EXPEDITION TOOLS

Packing tools for the yard is a bit like planning for a hiking trip: You must carry every ounce of weight you bring. With that in mind, pack the bare essentials and leave the backup in the car, just in case. Here are the must-have tools to drop into your bag for an efficient and painless hunt.

IN THE TOOL BAG

- Short pry bar
- 3/8-inch-drive ratchet set (standard and metric)
- Hammer
- Pliers
- Tin snips
- Hacksaw
- Screwdrivers
- Combination wrenches
- Allen wrenches
- Safety glasses
- Gloves
- Sunscreen

IN THE CAR

- Long pry bar
- 2 feet of pipe (breaker bar/bludgeoning stick)
- 1/2-inch-drive socket set
- Big hammer
- Coveralls and cardboard (for on-ground work)



WHAT TO EXPECT

The scariest part for junkyard first-timers is passing through the gates. Before stepping foot in the yard, a clerk will ask for your signature on a brief document that absolves the company of liability in case you do something stupid like drop an engine on yourself. Some places charge a nominal fee for entry as well, usually about a dollar. Consider this cheaper than paying for a movie and way more educational. In well-operated yards such as Parts Galore in Flat Rock, Mich., there is an underlying logic. The in-demand stuff is kept up front—that's where you'll find plentiful vehicles prone to frequent breakdowns or high accident rates. Conversely, examples of cars that are rare or older or don't break down much will probably be all the way in the back, with a gradual progression between.

Lots are often divided by vehicle manufacturer or point of origin—domestic versus Japanese versus European, or GM versus Ford versus Toyota, and so on; think of it as the difference between Dewey Decimal and alphabetical library systems. If you're lucky, a map of the grounds is posted. Of course, your local yard may be a mess of cars with no logic whatsoever. Some owners are just lazy.

The first thing to look for is the

**ASSOCIATE AUTO EDITOR BEN WOJDYLA ON WHEN TO JUNKYARD**

I go to junkyards, or auto recyclers, as they like to be called these days, when I feel the need to be inspired. Most of the world's best ideas are already out there, so diving into old VWs or busted Aerostars reveals design failures and successes. More often than not, I'll come away empty-handed but greasy and happy.

price board. Rather than put tags on all the items on every car, modern junkyards post a list of the different parts in cars and generic prices for each. Because the board doesn't care if a radiator comes from a Ford Escort or a Mercedes C-Class, the savings against new parts can be staggering.

While prowling for parts, don't jump at the first one matching your needs. Look around for the *best* example and inspect it carefully, making sure it isn't damaged. Parts

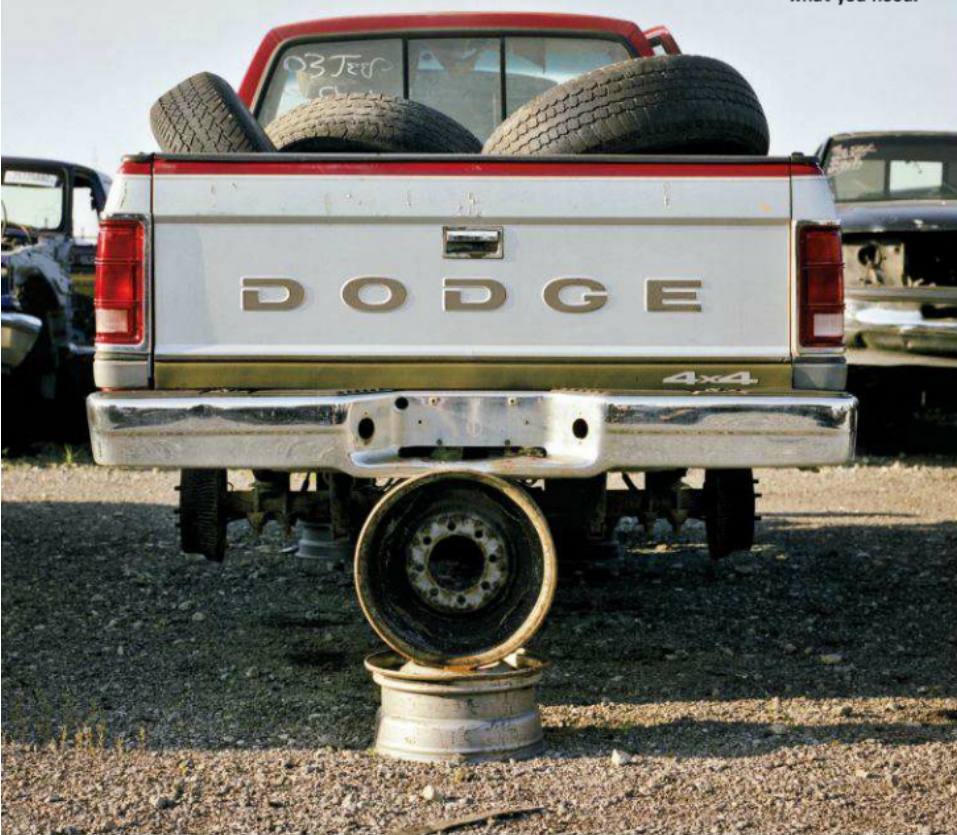
Galore has a database of all interchangeable components so you can find all the possible cars that could contain a replacement for your missing fuel cap or broken window-control-panel switch. Before buying an electrical component, test the part to ensure it functions. Junkyards usually have 12-volt sources, such as batteries, that you can use.

Sometimes inflicting structural damage on a vehicle is the fastest way to pull a part: Crossmembers, brackets, and wiring get chopped up all the time—just try not to destroy anything someone else might want. Be aware not everybody visiting these places works safely, so before crawling around, inspect your quarry for safe working conditions. Move on if something looks fishy. After finding what you're looking for and extracting the thing, take it up to the clerk you passed on the way in; tell her what it is, and pay. Some cheaters will call expensive items cheap ones to get a better price—that can get you banned from the grounds if you're busted.

Tires and tailgates are hot commodities. This truck has sheet metal, glass, and engine bits. Take what you need.

THE FUN STUFF

Most people go to junkyards for parts; handles, cylinder heads, lights, glass, body panels, and suspension pieces are popular. There are other things to do in junkyards, though. Treasure hunters pick out expensive parts and sell them online—airbag modules and computer boxes are targets here. But there are other treats to be found. A wall of metal hubcaps or a chandelier made of hood ornaments can spruce up the garage nicely. You can find switches, speakers, air springs, and other widgets useful for DIY projects. My favorite junkyard pastime is learning. Every car is made a little different, and any engineer will tell you the best way to understand how a thing works is to take it apart. Find a car with a part you don't understand, such as a differential or transfer case, take it apart, and then try putting it back together. If it doesn't go back, that's okay. Got a big project coming up and want some practice? Junkyards are a great way to try out a repair or modification before the real deal. The junkyard is really what you make of it—whether you go for parts or mechanical voyeurism, just make sure to get your hands dirty.



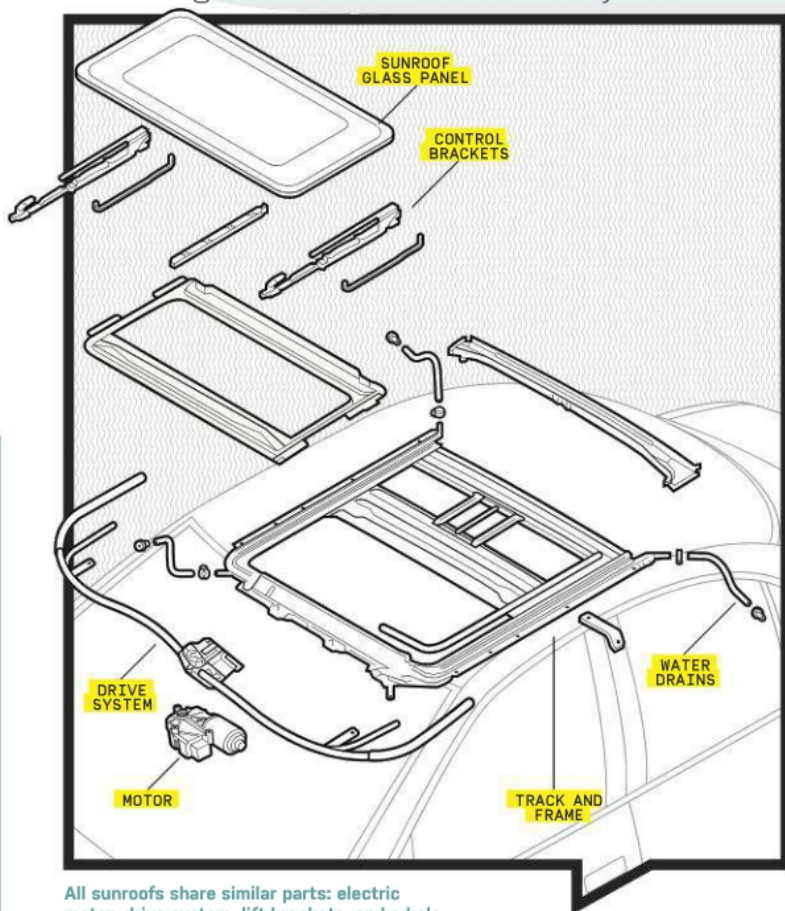
Car Clinic

BY
BEN WOJDYLA

ILLUSTRATION BY VIC KULIHIN

Sun (and Snow?) Roof

The sunroof in my Pontiac Sunfire has been getting fussy lately. Sometimes it initially won't close but finally does after a few tries, and it's making some bizarre popping and scraping sounds. With winter coming up, I want to get it fixed. Can I do this myself?



All sunroofs share similar parts: electric motor, drive system, lift brackets, and a hole in the roof filled with a metal or glass panel. Eventually they almost all go wrong.



You'd think sunroofs would be just as reliable as power windows, but turning a sliding panel on its side makes the mechanics far more difficult. A sunroof doesn't just slide back and forth; its mechanism must also tilt the panel up and down to accommodate the sliding and venting motions. So in addition to the electric motors and switches and slides in windows, sunroofs have plenty of additional parts—which are typically the ones that break. Popping and scraping noises are generally not happy sounds for cars to make; in a sunroof they indicate surfaces binding, drive gears slipping, or, put plainly, that something mechanical isn't working correctly. It'll probably break for good when it's least convenient (and raining).

There are two approaches to repairing an ailing sunroof: the first is to fix what you've got, the second is to replace the whole megillah. All the greasy bits of sunroofs live between the roof sheet metal and the headliner. Before you start pulling the car apart, find a place to work inside or check the weather forecast—being caught with a hole in the roof during a downpour wouldn't be fun. The first thing to try is removing the glass panel. If you can, tilt the sunroof panel to the "vent" position, which should give access to the screws holding the panel. Remove them, and with the sunroof glass off, you should gain access to the moving parts for an easy inspection. Look for cracked or stripped gears, a buildup of dirt and debris, or anything else that looks like a problem. With the glass panel still off, turn on the car and cycle the roof control through the open, close, and vent positions to identify problems.

In your case, it sounds like you might be able to get away with replacing the gear on the motor at the front of the sunroof, but without opening it up, it's impossible to know. If you do find and fix the problem, clean everything, then slather it with lithium or marine grease for smooth future operation. If you

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find nothing, don't bother putting the sunroof back together because you're just going to end up removing it all anyway. Installing a new sunroof is a big job—you'll have to take off the interior trim around the door pillars as well as any overhead handles or dome lights, then pull the headliner down, disconnect the sunroof wiring harness, and unbolt the whole mechanism. It's in one big rectangular piece called a cassette, which should swap for the new piece without any fight. Be sure to do a function test before putting the interior back together; it may need a little jiggle for a perfect alignment. To answer your final question, yes, you can do this repair, but it's complicated enough that it may be worth the cost to have a mechanic do it.

Cause for Alarm

I own a 2007 Nissan Altima with an electronic key fob. I detest the always annoying, never useful alarm that sounds the horn every time the alarm button on the fob is inadvertently touched. Is there a way to kill, maim, or otherwise incapacitate this nuisance? The dealer says no, but surely there's a solution.

Your dealer isn't very imaginative. Your car uses Nissan's Smart Key system, which means you don't have a proper key anymore, just a fob and a pushbutton to start the car. Accidentally pushing the red panic button momentarily activates a microswitch that passes current to a microchip, giving the command to sound the alarm. Don't fret: You can disable that whole process by modifying the fob. Get into the key fob's innards by removing the metal emergency

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W

WEEKEND

THE RECYCLER

Garbage

The EPA estimates that the average American tosses out 94 pounds of garbage a month, much of it recyclable. Why not repurpose it for use around the garage? Here are a few easy things you can do with a razor knife and plastic bottles.

[a] Pop bottle

Slice off the bottom and remove the cap to make a funnel.

[b] Oil container

Cut along the center to use as pencil holders or stackable parts bins.

[c] Bleach bottle

Form a scoop for winter salt or kitty litter; use the bottom as a pan to catch drips or mix epoxy.

[d] Milk jug

Carve a hole in the side to make a hardware stash with a convenient handle.



key housed inside the body, then separate the front and back halves of the fob by sticking a knife or screwdriver into the indents at the sides. Now gently pull the circuit board out of the front half. I can think of a couple ways to fix your problem permanently from here.

If you're technically inclined, find the microswitch the alarm button activates and desolder it from the board. This is best left to the electronics nerds, but it's a definite solution. Some of the pads may need to be jumpered to provide circuit continuity, but if you're dorky enough to desolder, you can figure this out too.

If that's too technical for you, try putting a dab of hot glue or superglue on the microswitch itself. This will prevent contact even though the outer button will still depress. Finally, try squirting superglue into the crack around the alarm button from the back. If the outside button can't move, the alarm won't go off. These fobs are expensive, so keep that in mind while diving in for modifications. **PopMech**

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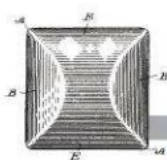
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A BRIEF HISTORY OF... BBQ Grills

From its humble Native American origins to today's high-tech grills gone wild, here's how this iconic device evolved. BY AMANDA GREEN

Start
here!



17TH CENTURY

The Arawak tribe of Hispaniola cooks meat on a frame of sticks over a fire, calling it *barbacoa*. No surprise: Spanish conquerors take the idea.



1897

Ellsworth B. A. Zwoyer patents a design for charcoal briquettes. Sadly, the Kingsford Products Company—started by Henry Ford in 1921—often gets the credit for creating the briquette. (Ford was looking for a way to reuse wood scraps and sawdust from Model T assembly lines.)

1952

George Stephen, a welder at Weber Brothers Metal Works, cuts a metal buoy in half to make a dome-shaped grill. He uses the top half as a lid that seals in flavor and evenly distributes heat, and adds vents to get oxygen to the fire. The iconic Weber grill is born.



1980s

Infrared burner inventor Bill Best adds his ceramic burners to a BBQ. Propane heats the tile, which emits infrared radiation and cooks food directly. Restaurants love them: They grill meat evenly and lock in juices.

1994

Your mom—and everyone else's—buys the George Foreman Lean Mean Fat-Reducing Grilling Machine. The clamshell design grills meat at the top and bottom while draining fat. Over 100 million are sold.



2000

Infrared grills aren't just for chefs anymore. Best's patent expires, leading to the production of more affordable infrared grills. At \$500 to \$1,000, they still cost a lot of bones.

18TH CENTURY

BBQ comes to southeastern America, where pigs are pit-roasted for hours and devoured. Different styles emerge during westward expansion, varying in sauce, cut of meat, and use of wood smoke. All taste great with beer.



LATE 1940s

In the postwar boom in suburban lifestyle, open brazier grills become a backyard fixture. But the grills—and thrills—are cheap: They often burn out without cooking it, and ash storms are common on windy days.

1960s

In a bid to get customers to buy more natural gas, William G. Wepfer and Melton Lancaster of the Arkansas Louisiana Gas Company redesign a charcoal grill to run on bottled propane. The resulting grills are pricier but easier to use and soon become the new backyard favorite.

1991

The Fresh Prince (aka Will Smith) shows off his grill skills—and raps that “the smell from a grill can spark up nostalgia”—in the music video for “Summertime.”

2004

The largest grill in the world is built on the Discovery Channel's *Big* show. It measures 15 feet 3.75 inches high, 20 feet 2.25 inches wide, and 8 feet deep.

2012

Finnish Design Shop debuts the City Boy Picnic grill, a sleek, tiny (8.7 inches tall, 7.1 wide) gas cooker that allows urbanites to pretend their fire escape is a country deck. Grill on!



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